Engineering News

Volume 76, No. 4
Issued Every Thursday
Hill Publishing Company

NEW YORK, JULY 27, 1916

Price, 15 Cents
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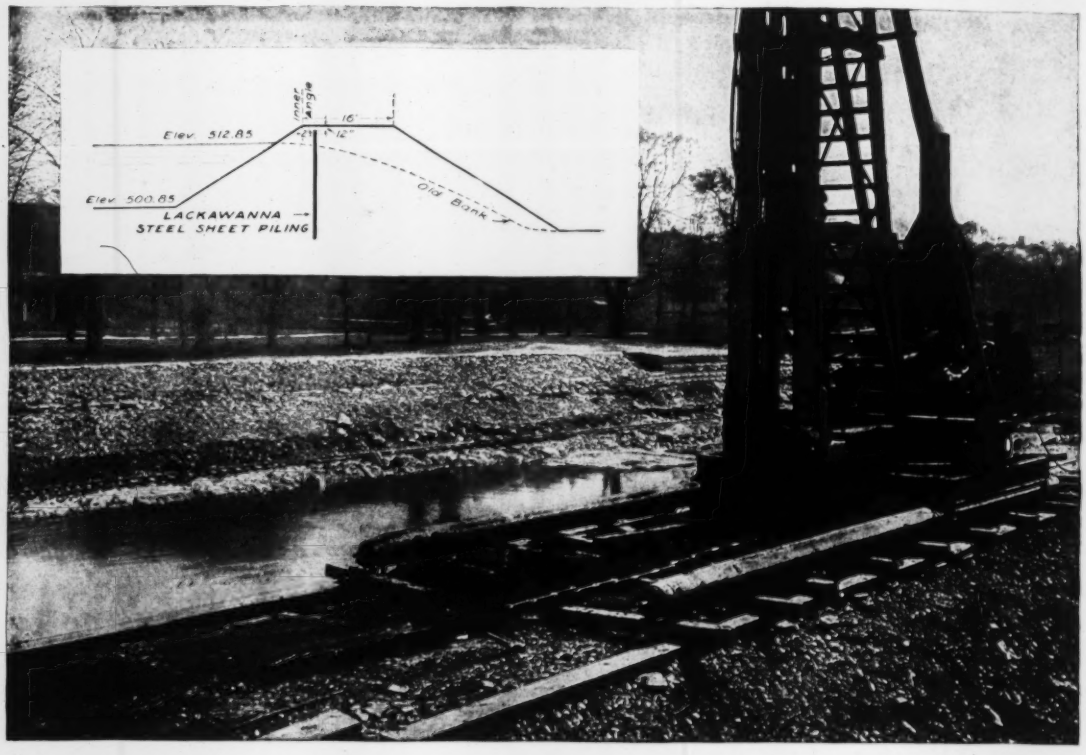

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Engineering News

VOLUME 76 JULY 27, 1916 NUMBER 4

Power Plants and Factories Moved at Seneca Falls

A complete rearrangement of the hydraulic power plants and various manufacturing establishments in Seneca Falls, N. Y., has been completed. This has occasioned what is probably the most complete revision of hydraulic and industrial conditions seen in any town in the eastern part of the United States, and it brought with it a variety of engineering and legal problems.

In the construction of the New York State Barge Canal through the manufacturing village of Seneca Falls, replacing the old Cayuga and Seneca Canal, the state engineers decided that the best canal arrangement would result from the construction of a single dam and a flight of two locks at the eastern limits of the village, although this would flood all the water powers and destroy water rights at the three dams upstream through the town and necessitate moving a large number of factories and dwelling houses out of the valley.

The condition of the valley of the Seneca River through the village before the Barge Canal construction was started is shown by the accompanying perspective sketch (Fig. 2). All the buildings along the course of the stream have been removed, with the exception of the business blocks along Fall St., from the bend west, on the north bank of the river. The buildings in the vicinity of the Lehigh Valley station remain, but it has been necessary to raise the level of the railroad yards about 4 ft. The basements of buildings along the south side of Fall St., on the north bank of the river, have been flooded out, so that it has been necessary to fill them up. Many brick buildings have had to be rebuilt with reinforced concrete from foundations to above water level.

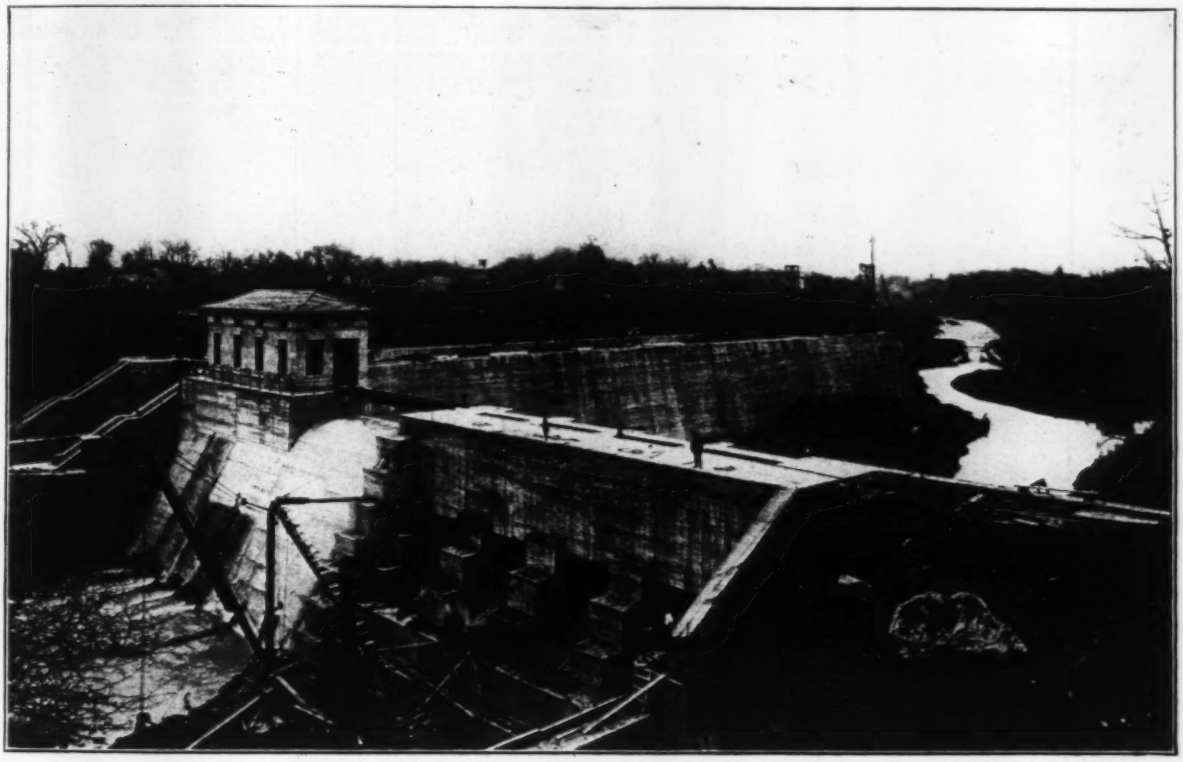


FIG. 1. DAM 2, CAYUGA AND SENECA BRANCH OF NEW YORK BARGE CANAL
Concrete steps in the foreground show the site of the station of the Seneca Power Corporation

In the case of the Episcopal church the damages secured made it possible to build a parish house taking the place of the basement facilities formerly used.

The village trunk sewer (a 24-in. vitrified pipe) lay in the valley to be submerged, and it was changed to a 20-in. cast-iron pipe with lead-calked joints, from the downstream side of the dam up for about ¾ mi. A 20-in.

cast-iron pipe also was laid on a timber crib to carry the sewage from the north side of the river.

Figs. 3, 4 and 5 show close views of the valley at the site of the Cast Thread Fitting and Finishing Co. below the Clary dam, looking east. A good idea is given of the changed conditions throughout the whole stretch of redeveloped territory.

The dam shown in Fig. 1 has eliminated five locks in the district shown by Fig. 2 and backed the water up in a single level stretching upstream about 2 mi. to the village of Waterloo, where a single lock replacing two low-level locks permits the passage of boats from the canal to Seneca Lake. By lowering the pool level below the dam a sixth lock, 5 mi. east, was eliminated.

Consolidation of Water Rights

At the various works scattered up the river through the village there were altogether something over 25 points of diversion for water from the river or supply races.

To carry out plans in building the Barge Canal here, the state was faced with damage claims for water rights alone of upward of $2,000,000. It was seen that if the state acquired these rights it would have no use for the power created at the new dam except for a comparatively small amount needed for the operation of the locks. It was also known that the state could not lease or sell this power at a figure to pay the interest on the cost of the rights. The state, therefore, entered into negotiations with the owners of the water rights for the appropriation of their physical property only, leaving the owners in possession of their several water rights, which it was proposed to transfer to the site of the new dam. To accomplish this change, it was necessary for the owners of power rights to pool their issues and organize into a single corporation for the development of power at the new dam. The one great obstacle standing in the way of the organization of such a company at the outset was the determination of the proper proportion of the stock in the new corporation which each power owner should have.

The canal construction destroyed 15 owners' power rights appurtenant to three dams. As is usual in such cases, the owners along the different races could not agree as to the division of the water nor to the heads at the various dams. To make matters more complicated, it was known that many of their rights were conveyed in old and obsolete terms and, in fact, some in such terms as seemed impossible of interpretation in anything like an exact manner. The owners could not settle these matters among themselves, and they realized that to go into the courts would entail untold expense, ruin many of the owners, and some of them would not live long enough to see the end. They therefore submitted the whole question of their water rights to arbitration and appointed Mortimer G. Barnes, a consulting engineer of Albany, N. Y., as arbitrator working under the code to determine their rights and apportion the stock in the new company among them, his findings to be final and binding on all parties. Ernest G. Gould, of Seneca Falls, was appointed general counsel to the arbitrator. Hearings were held at which sworn testimony was taken to give further light on the transfers, maps and other legal documents offered in evidence. Aside from this the arbitrator made surveys and investigations of races, turbine capacities, etc.

The powers in the village of Seneca Falls were located along five levels which the arbitrator designated as upper, middle and lower levels. In order to determine the proportionate amount of power each owner should have of the whole, it was of first importance to determine the head under which the different powers acted or were entitled to. This problem was complicated in the extreme. Supreme Court decisions fixed the elevation of the dams in some instances, and partition suits fixed the elevation of the same dams at different heights. The actual elevation was still different from either. An engineering interpretation of former conditions and deeds called for still a fourth height. The belief and desires of some of the owners were for yet another height. Probably no one of the different theories was right; surely the powers were not developed under any fixed and definite plan. To make the matter still more complicated the state had constructed a canal in the midst of it all and upset many of the calculations. Out of all this jumble of conditions, elevations were established that satisfied all owners, as follows:

Powers on	Ft. Head
Upper dam	12.72
Middle dam, south side	13.80
Middle dam, north side	15.00
Lower dam, north side	10.80
Lower dam, south side	15.50

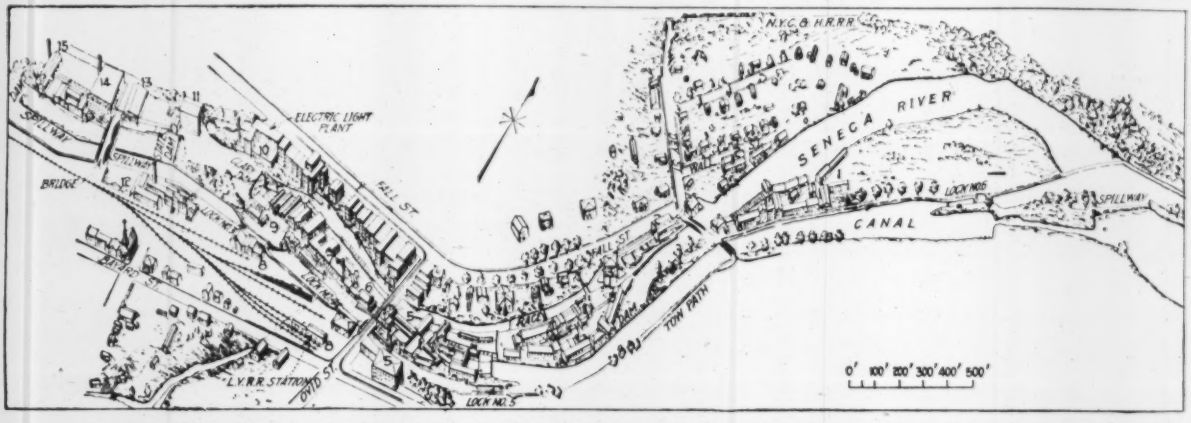
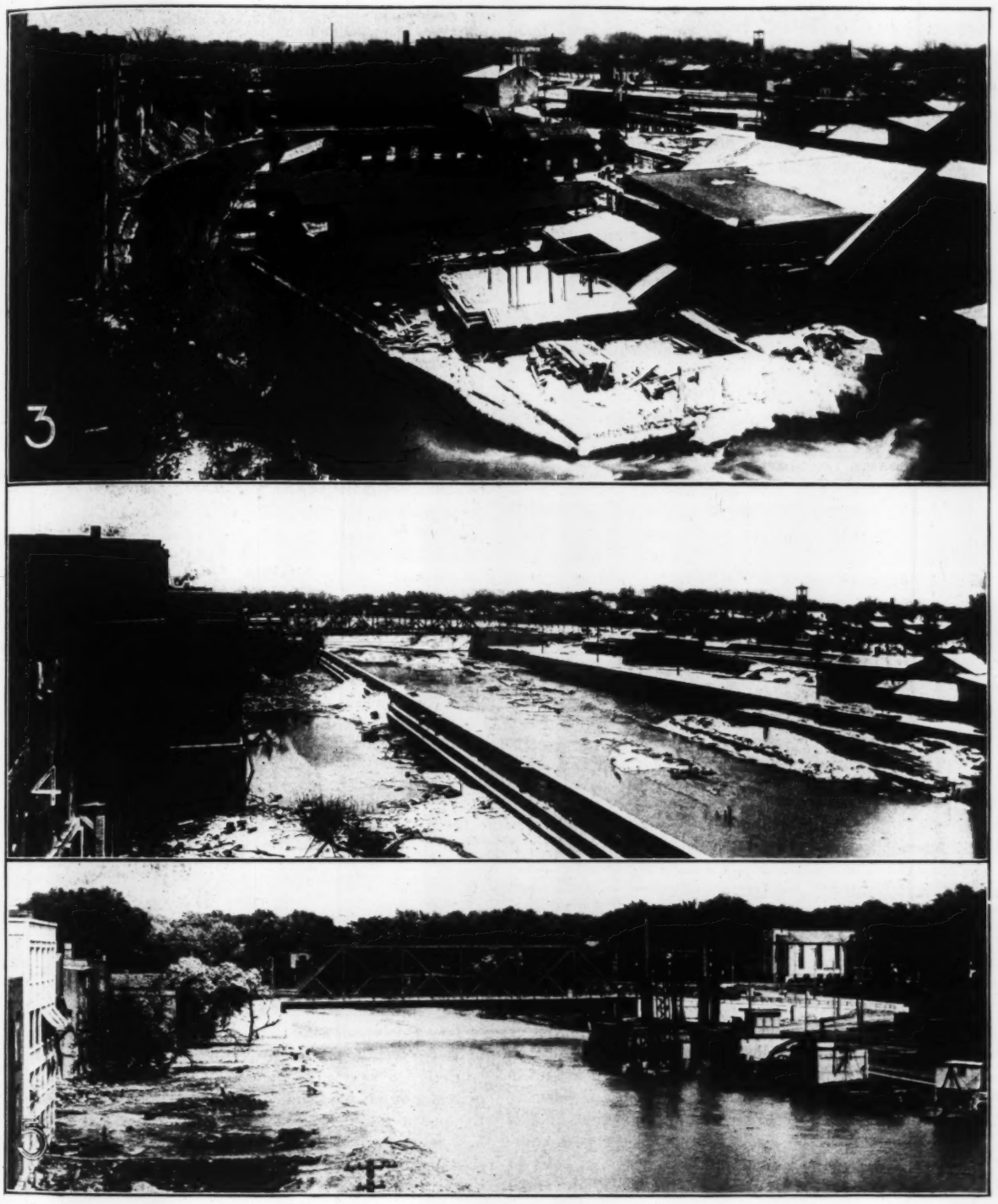


FIG. 2. VALLEY OF SENECA RIVER IN SENECA FALLS BEFORE CANAL RECONSTRUCTION

From a drawing made by H. W. Benedict under the direction of R. E. Phillips, Supervising Engineer

Figures indicate the following works affected: 1—Rumsey & Co.; 2—M. Fritz and H. W. Douglas; 3—C. A. Braman; 4—American-La France Co.; 5—Goulds Manufacturing Co.; 6—Roberts Milling Co.; 7—Ivory Button Manufacturing Co.; 8—Lehigh Valley R.R.; 9—Cast Thread Fitting and Finishing Co.; 10—Clary Electric Light Plant; 11—National Advertising Co.; 12—Seneca Falls Woolen Mills; 13—F. Maier & Sons; 14—Seneca Falls Manufacturing Co.; 15—Seneca Falls Paper Co.



FIGS. 3 TO 5. TYPICAL CLOSE VIEW OF CHANGED CONDITIONS IN SENECA FALLS

Views taken from about same location at different times. Fig. 3—Feb. 18, 1913, original condition. Fig. 4—Oct. 23, 1915, before backfill. Fig. 5—July, 1916, work complete

In the matter of title the problem was still more complicated than as to head. The powers on the upper level were originally owned on both sides of the river. The north-side rights were sold and apportioned to abutting owners in proportion to their waterfront. This was later complicated by subdividing and reselling the water rights. In some cases the land was sold and the water rights retained. In other cases the water was sold and the land retained; and in selling the measurements did not agree with the total, so that controversies thereby arose.

Portions of the power rights on the south-side upper level were sold to different parties on the north side, they in turn selling in part to other parties. The south-side rights originally covered half of the flow. The owner sold ten run of stone, thinking he had sold half. He retained seven first rights and sold to the north side, as a

second preference, the next four rights; then he sold three run attached to the south side. The total flood rights went to the north-side owners, and the question arose as to how great they were. This brought in the question of heads—particularly as at the time the south-side owners bought their rights.

There was not much controversy as to the rights on the middle level, north side; at least it was not brought out in the hearings. The greatest complications of all were found on the south-side middle level. The conveyances were in terms of run of stone, inches of water, water to run a 10-ft. wheel, billies, water to run a cotton mill or a sawmill, etc. These rights were complicated by subdivisions, preferences, obsolete terms, lack of knowledge of head at time of conveyance, no knowledge of size of cotton mill or billies, reconveyances and combination of preferences and litigation and controversies as to head.

At the lower level, north side, there was no controversy as to rights. The water was divided into twentieths and so sold. The only trouble was that more than 20 twentieths were sold. The south-side lower level was all owned by one party and no question raised as to title.

In view of this indefiniteness other methods of solving the problem were sought. An examination of the records on another dam on the same stream where the conveyances were all in one term established what the people at that date believed the capacity of the stream to be in the units used. This information was used to check the number of units and assumed values at the dams in question. Next, the capacities of the openings to the wheels were computed and the powers tabulated. The next step was to measure and compute the capacity of the wheels installed. Happily it was found that all these methods checked within reasonable limits.

The important rights on the river, reading downstream, are as follows:

	Power of Wheels, Hp.
Upper Level, North Side	
1. Seneca Falls Paper Co.	200
2. Sarah F. Allen	Not developed
3. Seneca Falls Manufacturing Co.	285
4. Fred Maier & Sons	142
5. National Advertising Co.	218
Upper Level, South Side	
6. Seneca Woolen Co.	300
Middle Level, North Side	
7. Clary Bros.	224
Middle Level, South Side	
8. Cast Thread Fitting and Finishing Co.	240
9. Ivory Button Manufacturing Co.	160
10. Roberts Milling Co.	85
11. Goulds Manufacturing Co.	80
Lower Level, North Side	
12. American LaFrance Fire Engine Co.	Abandoned
13. Chester A. Braman	Abandoned
14. Climax Specialty Co.	Abandoned
Lower Level, South Side	
15. Rumsey & Co., Ltd.	110

All this information, when carefully studied, gave a process of eliminating most of the unknown terms. After weighting the preferences, a division of the power was arrived at that satisfied all parties. Another hearing was then held at which all stipulated that the findings of the arbitrator were satisfactory and final. Thus closed what might have been a long and rich harvest for lawyers and expert witnesses. A settlement with the state was consummated, and the consolidated power rights are now being developed.

Seneca Power Corporation Plant

Before this settlement was made, however, the state had completed the locks and dam, but had left openings in the dam for the penstocks. As the dam was completed, the design of the power house brought some novel engineering features and problems not ordinarily found.

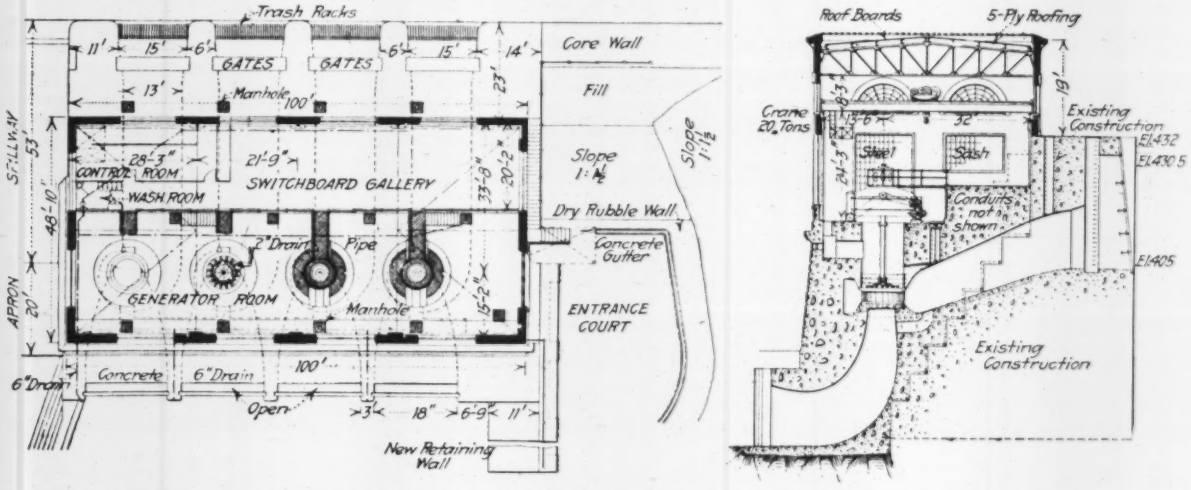
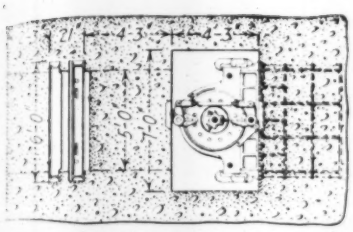
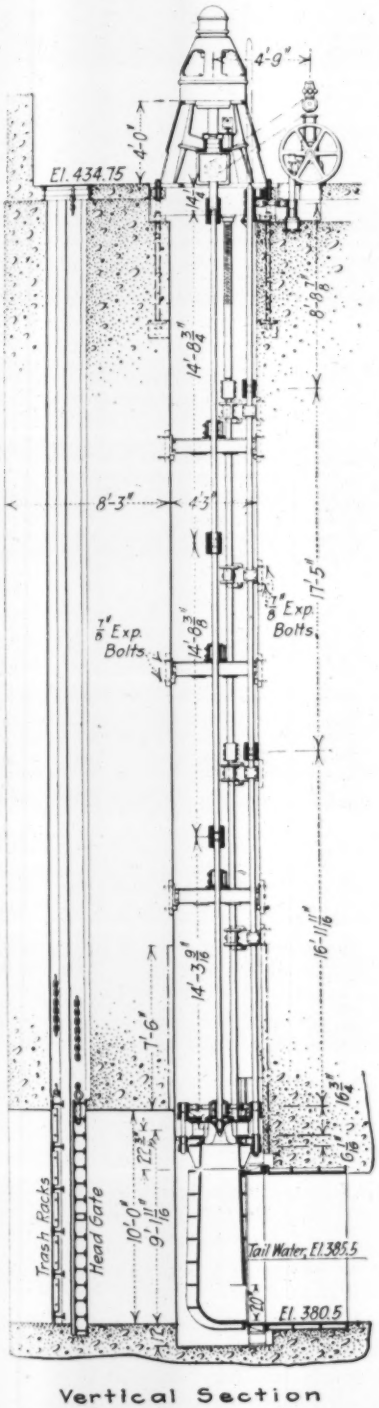


FIG. 6. HYDRO-ELECTRIC STATION OF SENECA POWER CORPORATION AT DAM 2, SENECA FALLS

The construction of the dam prior to the construction of the power house required that the power house must be designed as a dam and stable against pressure in the penstock in all directions; this had to be overcome within the power house itself. As a consequence excess weight had to be provided in the building, and all had to be thoroughly tied together by steel. There was no opportunity to tie this back into the dam. To overcome any hydrostatic pressure that might be found in the joint between the dam and the power house, a complete system of drains was provided; and the specifications require that all old concrete must be thoroughly washed with acid before depositing new concrete, in order to secure so far as possible a partial bond.

The lower guide wall to the north end of the dam extends 50 ft. downstream from the face of the dam. It is founded on a yielding foundation 16 ft. above the necessary excavation for the power house. The wall is 34 ft. high, of gravity section, and sustains an almost liquid mass of earth. It is necessary to underpin this wall and



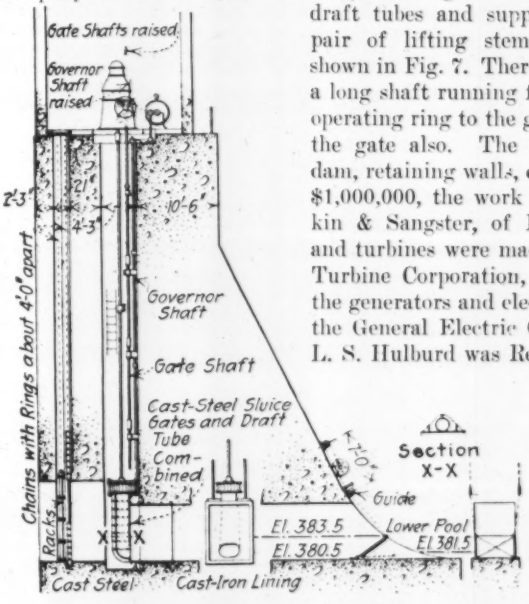


build a new wall from its base to the bottom of the excavation for the power house. This work is under way. The south side of the power house is the north side of the spillway section of the dam. Water flows over the dam 4 ft. deep and is 16 ft. deep on the apron, along which a guide wall must be built extending under a portion of the apron. No choice could be exercised in the design of the headworks, such as gates, trash racks, stop logs, etc.; openings were left for these purposes.

The general design of the Seneca Corporation's station is shown in Fig. 6. The development calls for four units of 2,500 b.hp. each at 48-ft. head. The power is to be used electrically and is leased to the Central New York Gas and Electric Co. Day & Zimmerman are contractors for the power-house construction. S. Morgan Smith Co. is contractor for turbines and governors, and the Westinghouse Electric and Manufacturing Co. for the electric equipment. Mortimer G. Barnes, of Albany, is engineer for the power corporation.

Barge Canal Power Plant

In designing the dam and locks of the Barge Canal at the eastern limits of the town it was not proposed at first to generate power for the service, and provision was made for only four sluice gates. Later on, the plans were changed to provide for two 50-hp., 700-r.p.m. hydraulic turbines working under 44-ft. head. As no turbine pits had been provided, it was necessary to mount the turbine casing on top of the sluice gates, combining the sluice gate and draft tube, as shown in Fig. 7. This does not give ideal hydraulic conditions, but the arrangement has worked quite satisfactorily nevertheless. The turbine casing rises with the gate, the runner meantime being fixed and hanging in the draft tube. The vertical shafts are very long, hanging down from the generator about 43 ft. 8 in. in three sections, with three intermediate guide bearings. Where the sluice gates are combined with the draft tubes and support the turbines, a pair of lifting stems are provided, as shown in Fig. 7. There is also necessitated a long shaft running from the wicket-gate operating ring to the governor, rising with the gate also. The cost of state locks, dam, retaining walls, etc., was a little over $1,000,000, the work being done by Larkin & Sangster, of Buffalo. The gates and turbines were made by the Hydraulic Turbine Corporation, of Camden, N. Y., the generators and electrical equipment by the General Electric Co., of Schenectady. L. S. Hulburd was Resident Engineer for the State up to 1916; since then H. C. Smith has acted in that capacity.



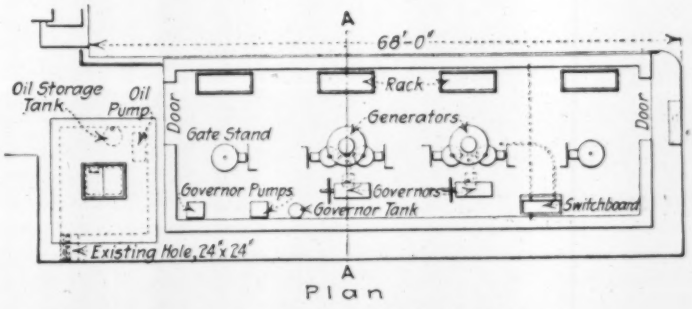
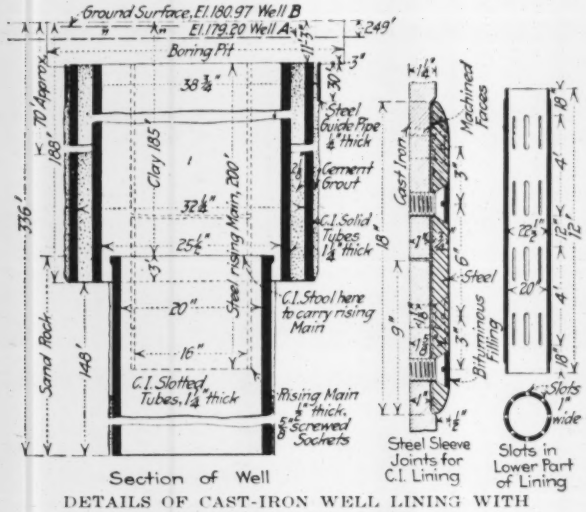


FIG. 7. BARGE CANAL POWER PLANT AT SENECA FALLS, WITH TURBINES ON SLUICE GATES

Lining Wells with Cast Iron and Cement Grout

On account of the corrosive nature of the water two large and rather deep bored wells for the water-supply of Tunbridge Wells, England, were lined with cast iron instead of steel pipe. For a considerable portion of the depth the lining was double, filled between with cement grout, and with grouting also between the outer tube and the bore hole. There was a steel guide tube for the first 30 ft. of the bore, and inside the lining there is a steel rising and suction pipe, thus making four concentric tubes and two rings of grout for a part of the depth of the wells. The object of the grout between the double cast-iron tubes was to protect the outer tube in case the inner one was eaten away by the water. The work was described in detail by W. H. Maxwell, Borough and Water Engineer, Tunbridge Wells, England, in *The Engineer* for May 5, 1916.

Two wells of the same diameter and of approximately the same depth were sunk, each from a boring pit about



DETAILS OF CAST-IRON WELL LINING WITH STEEL-SLEEVE JOINTS

12 ft. deep, from the bottom of which a steel guide tube slightly larger than the outer diameter of the outer cast-iron tube was sunk to a depth of 30 ft.

The total depth of each well is about 335 ft. from the original ground surface. The first 188 ft. of this depth is through clay and the remaining depth through water-bearing sandstone, the latter being separated by strata of pale, yellow clay. The water derived from the sandstone contains "salts which, although themselves neutral, may act as electrolytes, causing galvanic activity between dissimilar metals or between dissimilar parts of the same metal." Experience with other well linings in this locality and also laboratory experiments showed that steel lining would be unsafe but cast-iron lining safe. The dimensions of the various linings and other details are shown by the accompanying drawings.

The pipe used for the lining was cast in accordance with carefully drawn specifications as to both material and methods, and every length of it was subjected to test, both as to quality of metal and by a hydraulic pressure of 200 lb. per sq.in. Deflection tests of strips cut from the tubes were also made. Each length of pipe was cleaned directly after casting, immersed in boiling water for further cleaning, and to raise the temperature of the metal, and then dipped twice in Angus Smith coating maintained at a temperature of 300 to 350° F. Before shipment, each length of pipe was "packed with soft material to avoid damage to the coating in transit."

The tubes were cast vertically in 12-ft. lengths. Each of the larger or 32¼-in. tubes weighed about 2¼ long tons.

The clay through which the wells passed was hard and impervious at first, but after being wet it softened to "a soapy consistency of very treacherous character." Settlements and side slips in the clay "were considerable, and at times caused some anxiety, especially in view of the close proximity of heavy engine foundations and three large pumping mains, carrying about 200 lb. pressure per sq.in., which had to be maintained in perfect order."

Slips also occurred in the sides of the boring pits. To avoid trouble of various sorts, interlocking steel piling was driven around the boring pits, but sufficiently far away from them to give room for sinking 12x12-in. pitch-pine piles. Girders were placed upon these piles to distribute the weight of the boring machinery. On the completion of the work, both the steel and wood piling were left in place, the tops of the steel piling being cut off to proper levels by means of the oxy-hydrogen flame.

A few weeks after the wells were sunk and lined, it was found that the 20-in. tubes in the sandstone were sinking, so that there was danger of losing the lap between these and the upper double tubes. Cement grout was therefore placed in the bottom of the space between the 20-in. tubes and the bore hole in the sandstone, to a depth of 7 ft. This stopped the settlement.

The method of placing the grouting between the two upper concentric tubes that formed the lining of the portion of the wells through the clay is thus described by Mr. Maxwell in his article:

> The portland-cement grout used in the annular space between the inner and outer linings and at the back of the outer lining was mixed to a thick creamy consistency, and all passed through a fine wire netting sieve of about ⅛-in. mesh in order to remove all lumpy or unmixed particles. In one boring the grout was simply poured into the tops of the annular spaces to be filled, thereby forcing out the water. The grouting thus continued until all spaces were full and the thick grout appeared at the tops of the tubes.
>
> In the second boring, which was of exactly the same size, the grout was inserted by a different method in order to check the quantity of cement used and to confirm the assumption that the spaces had been solidly filled. In this case a 1-in. diameter pipe was passed down the annular space for the purpose of conveying the grout down to the bottom of the cavity to be filled. The 1-in. pipe was fed with grout from a Greathead grouting cylinder and forced forward by compressed air. After discharging the contents of the grouting cylinder the 1-in. pipe was raised in the annular space by a previously calculated amount, so as just to reach the surface of the last deposit of grout. This process was continued until the space was quite full. On comparing the weight of cement used in this case with that used in the boring first grouted up it was found to be identical within a very trifling amount. All grouting operations once started were continued day and night, if necessary, without intermission.

The contractor for sinking and lining the wells was Isler & Co., Southwark, England. The cost of the two wells complete was "just under £6,000," or in round numbers, $25,000. This price did not include the 20-in. rising and suction mains inserted in the wells. Mr. Maxwell states that a week's test of the yield of the wells by means of compressed air showed a discharge at the rate of 30,000 Imp. gal. per hr., or about 1,700,000 U. S. gal. per 24 hr. Mr. Maxwell adds that had he had the necessary plant a larger yield could have been secured.

New Railway Bridge Over Ohio at Metropolis, Ill.

SYNOPSIS—The longest simple truss span ever built and the extensive use of silicon steel in the trusses are striking features of this bridge.

Work on the great railway bridge over the Ohio River at Metropolis, Ill., was resumed early in the spring and is being prosecuted actively. The bridge is specially notable for having a double-track channel span 720 ft. long between end pins (the largest simple truss span ever built), for the extensive use of silicon steel in the main members of the trusses and for the exceptionally high live-load assumed in the design. A description of the bridge was given in *Engineering News*, July 29, 1915, and tests of the steel were given June 8, 1916.

The first truss at the north end is 300 ft. long c. to c. of end pins and is followed by four spans of 552 ft., then the 720-ft. channel span and a 246-ft. deck truss span. There are steel viaduct approaches at each end, and these carry a concrete slab deck for ballasted tracks. The bridge will contain nearly 17,000 tons of metal, the estimated weights being as follows: 3,896 tons of structural steel and 144 tons of castings for the 720-ft. span; 8,603 tons of steel for four 552-ft. spans; 846 tons for 300-ft. span; 560 tons for 246-ft. span; 520 tons of casting for six truss spans; 1,539 tons of steel and 73 tons of casting for the north (Illinois) approach; 673 tons of steel and 32 tons of castings for the south (Kentucky) approach; total, 16,886 tons.

The substructure consists of eight main piers, built of concrete. Seven of these will have deep foundations, sunk by the pneumatic process in the sand and gravel of the river bed.

Progress of Construction

Work on the foundations was commenced in June, 1915, having been delayed for a time on account of conditions incident to the war in Europe. It has been interrupted to some extent by high water in the river. The status of this part of the work may be summarized as follows: Of the eight piers for the seven truss spans, Nos. 1, 6 and 7 (counting from the north end) have been landed at the final depth, and Nos. 2, 3 and 8 are under construction, with Nos. 4 and 5 not yet begun. Nos. 6 and 7 are those for the channel span. The low-water elevation is 284.2 ft. above sea level, and the caissons for the present six piers have reached the following depths:

	Depth Below Low Water, Ft.
1. Landed, pier completed	49.05
2. Not landed	18.91
3. Not landed	48.90
6. Landed, pier nearly completed	74.76
7. Landed, pier nearly completed	63.93
8. Not landed, no pneumatic caisson	4.70

For the truss span, material is being delivered, but no falsework for the erection has yet been placed. The 1,590-ft. viaduct approach at the north end has been completed, except for the two 90-ft. girder spans adjacent to the river spans. The steelwork is erected and the concrete deck slabs are placed, ready for ballast and track. The north approach fill, 6,000 ft. long, is well advanced, 69,000 cu.yd. having been placed out of an estimated total of 134,000 cu.yd. In the 570-ft. viaduct approach at the south end the concrete pedestals are completed and the castings placed ready for the column of the towers.

Design of Trusses

The assumed live-load provides for engines of the 2:8:0 class, of Cooper's E-90 loading, and a train load of 7,500 lb. per ft. of track. The structural design of the trusses is very heavy, as will be seen by the accompanying drawings of the 720-ft. span. The top chord, end posts and main verticals are of H-section, with channel-shaped built-up webs and a continuous transverse horizontal diaphragm.

Some of the connection plates are 1¾ in. thick and are of enormous size, and the main chord angles are 8x8 in., with metal 1⅛ in. thick. This chord and the main posts and diagonals are all riveted up, except that eye-bar diagonals are used in two panels at each end. The end pins for the shoes are 15 in. in diameter. The end panels of the bottom chord have four built-up channel-shaped webs 39¼ in. deep, connected by diaphragms. The bottom chord is of eye-bars, except in the end panels, as noted. The largest eye-bars are 16x1⅛ in., with 14-in. pins.

The floor-beams are 76¼-in. plate girders framed between the posts, with bottom corners cut away to clear the chord pins and the ends reinforced by diagonal channels, as shown. Between these are four lines of 62⅝-in. plate-girder stringers.

The trusses are spaced 37 ft. c. to c., as shown in the cross-section. It will be observed that this drawing shows only a single track, with ties carried by the two inside stringers. This arrangement is to be used until the traffic requires a double track, when the ties will be laid upon the two sets of stringers. The ties are 12 in. c. to c. and have steel tie-plates for the 90-lb. track rails. There will be outside guard timbers 18 in. from the gage side of the rail head. The inside guard rails are heavy angles, laid with the flange inward (to form a path for derailed wheels) and backed by a timber laid flat upon the ties. A temporary plank walk with hand-rail will be laid along the west side of the single track.

A special feature of the bridge, as previously mentioned, is the extensive use of silicon steel. Records of chemical and physical tests of the material were given in *Engineering News*, June 8, 1916. With steel of 0.30 to 0.35% carbon, the silicon averages 0.30 to 0.40%. This metal is used for the top chords, main posts, main diagonals and the end panels of the bottom chords. All other rolled structural material is of medium steel. The eye-bars and pins are of nickel steel.

Engineers and Contractors

This great bridge is for the joint use of the Chicago, Burlington & Quincy R.R. and the Nashville, Chattanooga & St. Louis R.R., forming the main part of a link to complete a new route from the Northern States to the

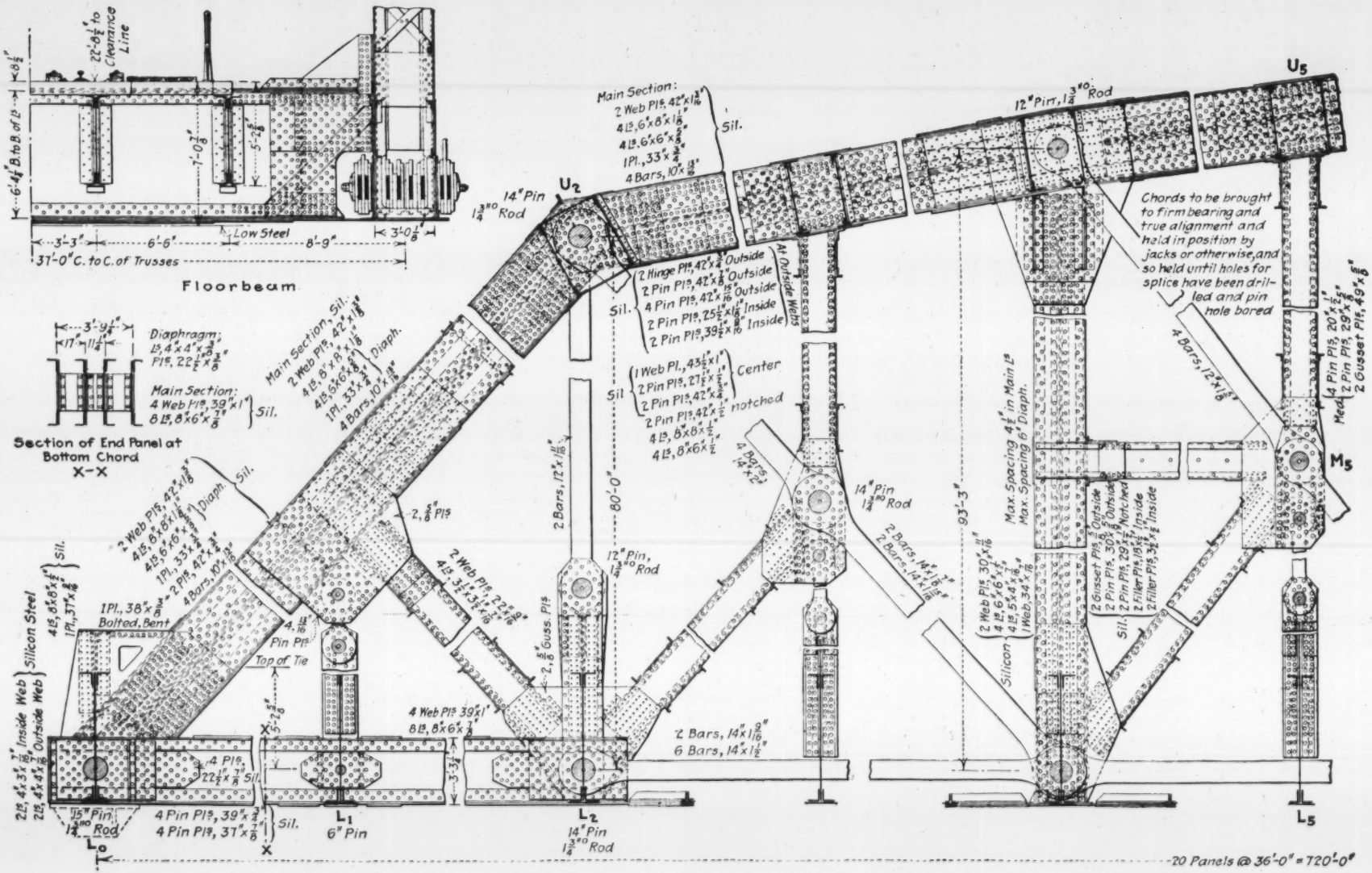

Floorbeam
Section of End Panel at Bottom Chord X-X
Low Steel
37'-0" C. to C. of Trusses
Chords to be brought to firm bearing and true alignment and held in position by jacks or otherwise, and so held until holes for splice have been drilled and pin hole bored
20 Panels @ 36'-0" = 720'-0"
U2
U5
L0
L1
L2
L5
M5

FIG. 1. ELEVATION OF END PANELS AND DETAILS OF FLOOR-BEAM OF OHIO RIVER BRIDGE AT METROPOLIS, ILL., THE LONGEST SIMPLE TRUSS EVER BUILT

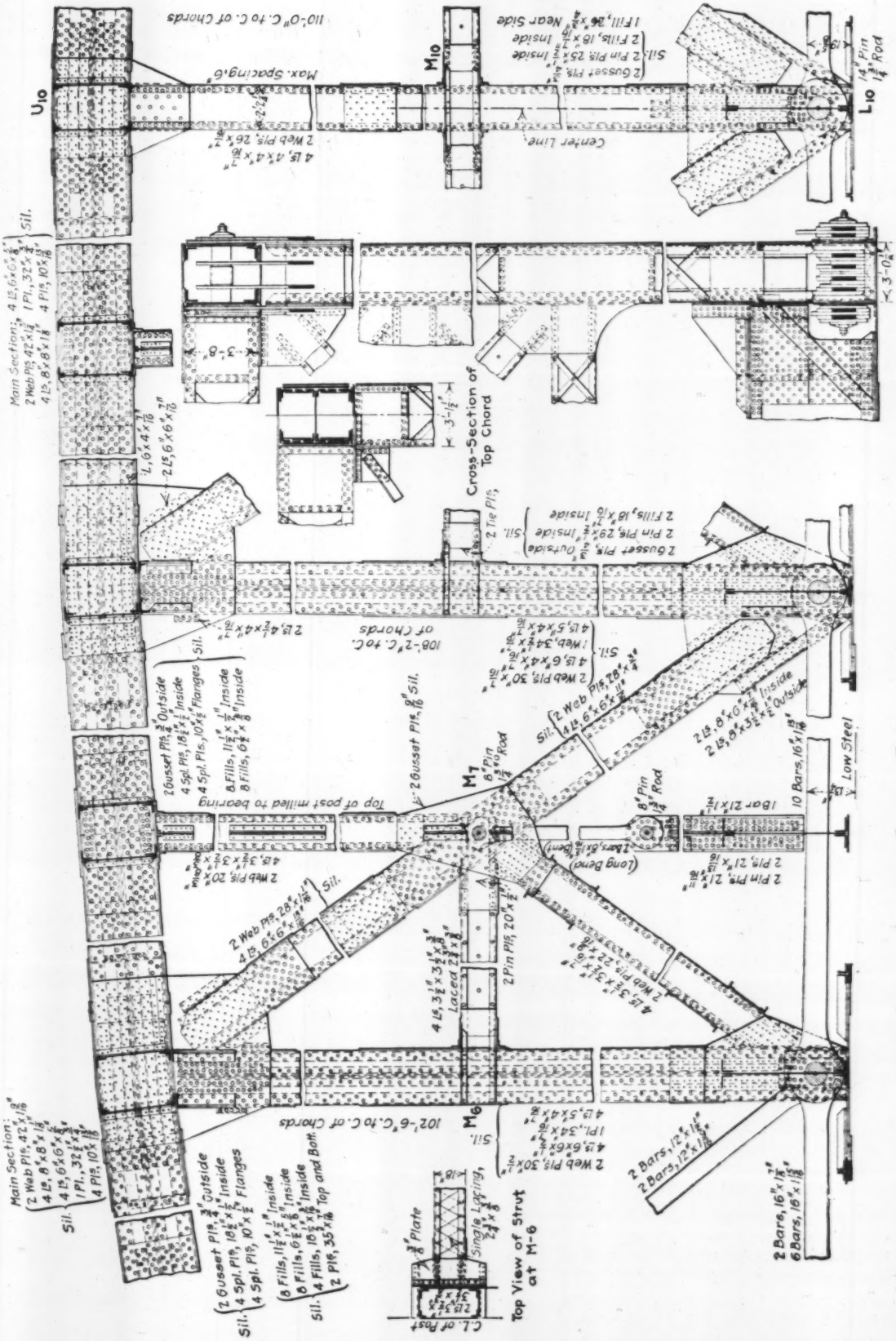


FIG. 2. MIDDLE PANELS OF METROPOLIS BRIDGE AND CROSS-SECTION OF CENTER POST

Gulf and Southeastern States. Its construction is entirely in the hands of the former road, and for convenience of organization a separate company was formed to construct the connecting link between Metropolis, Ill., and Paducah, Ky., a distance of 15 mi.

This line is known as the Paducah & Illinois R.R., the Chief Engineer of which was the late C. H. Cartlidge, Bridge Engineer of the Chicago, Burlington & Quincy R.R. The land portion of this line is now completed, communication across the river being maintained by a car ferry, with landing cradles, as described in *Engineering News*, Sept. 23, 1915.

The bridge was designed by Mr. Cartlidge, and all detail drawings were made under his direction in the railway company's office. All plans were submitted for approval to Ralph Modjeski, Consulting Engineer for the bridge. The Union Bridge and Construction Co., of Kansas City, Mo., has the contract for the substructure, and the American Bridge Co. has the contract for the fabrication and erection of the steel superstructure. The steelwork is being made at the latter company's shops at Gary, Ind. The inspection is in charge of Modjeski & Angier, of Chicago.

Million Square Feet of Cement Tile Used for Roofing

A recent example of the extensive use of reinforced-concrete tile for roofing is the new Chicago plant of the Crane Co. The buildings are of steel-frame construction, with reinforced-concrete floors and curtain walls. The architects were Graham & Burnham. The contractors were Lanquist & Illsley, and the Blome-Sinek Co. The roofing tiles were furnished by the Federal Cement Tile Co., of Chicago.

The roofs aggregate about 1,000,000 sq.ft., and different kinds of tile are used to meet varying requirements of the different buildings. These are shown in Fig. 1. The machine shop, generator room of power house, and buildings in which the finer class of work is done, have flat roofs of hollow tile in slabs 2x5 ft. These are 3 in. thick, with a 1-in. air space between the inner and outer 1-in. surfaces. The garage has a flat roof of single-thickness tiles 2x5 ft.; these are 1⅝ in. thick, reduced to 1¼ in. at the ends where they rest on the purlins.

The flat tile roofs are covered with composition roofing. They weigh (for the tile alone) about 18 lb. and 25 lb. per sq.ft. for the single-thickness and hollow tile respectively. With I-beam purlins, these tiles rest directly on the steel, but with channel purlins channel-shaped shoe tiles are placed on the top flange to give the necessary width of bearing.

The foundry, storehouse, boiler house, etc., have single-thickness pitched tiles. These tiles are 4x2 ft., 1 in. thick, with a lug at the upper end to hook over the purlins. The outer surface has a rib on each side, and when the tiles are butted together an inverted trough-shaped, or roll, tile is placed over the joint, as shown. This is sealed with elastic cement, making the joint air-tight. A rib or roll in the middle of the outer surface gives additional stiffness. These tiles weigh about 16 lb. per sq.ft. For the power house, hollow pitched tiles are used, of the same size but similar to the hollow flat tiles. These weigh 25 lb. per sq.ft.

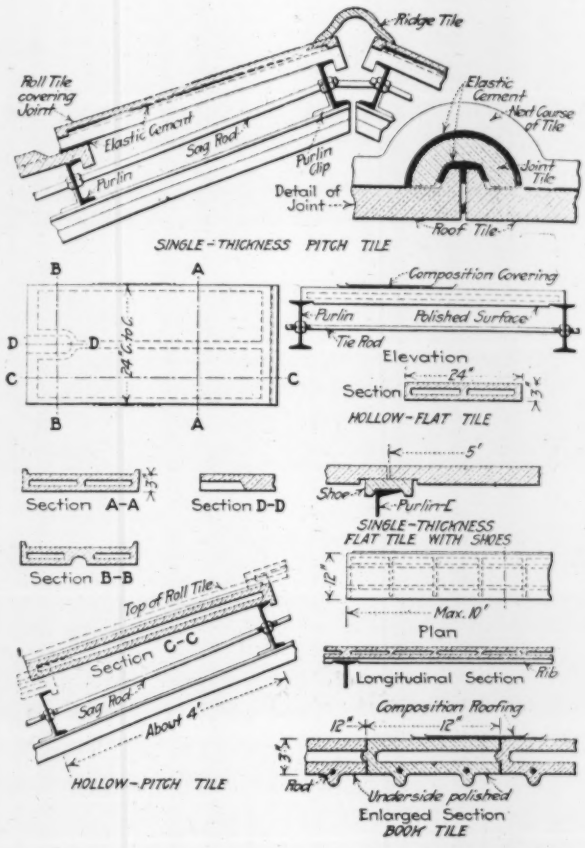


FIG. 1. TYPES OF CEMENT TILE FOR ROOFING

Where roof lighting is required, as in the storerooms, etc., glass-insert tiles are used. These are 2x4 ft., 1 in. thick, with a large pane of ¼-in. wire glass. The glass is set in the concrete during the process of manufacture, with a cushion strip around it to provide for expansion and contraction. These tiles weigh about 16 lb. per sq.ft. Fig. 2 shows a roof of this glass-insert tile construction at the plant of the Packard Motor Truck Co., and gives an idea of the amount of light thus supplied. Another

FIG. 2. SHOP ROOF OF CEMENT TILE WITH GLASS INSERTS (USED IN PLACE OF SKYLIGHTS)

special form of flat roof is made with book tile, in hollow slabs 1x10 ft., having tongue-and-groove joints and a 1-in. air space between the two surfaces. Fig. 3 shows the laying of a book-tile roof, to be covered later with composition.

The tiles are made of sharp torpedo sand and portland cement proportioned 2¾ : 1, and colored red. The mixture is made moderately wet, and is tamped by hand in metal molds. A special finish is given to the inner side of the flat tiles to produce a dense and polished surface. The reinforcement consists of a sheet of galvanized wire netting, except that light rods are used in the book tiles. The tiles are seasoned under cover for about four weeks.

The tiles for the Crane Co. plant were made at the manufacturer's factory at Hammond, Ind., and stored there until the steel roof framing was ready. By this arrangement they were taken directly from the cars to the roof, thus avoiding storage and rehandling at the site and insuring prompt delivery. From 50 to 100 squares (of 100 sq.ft.) were laid daily.

These tiles form a permanent roof, with little or no cost for maintenance and repair. Their use eliminates the

FIG. 3. LAYING ROOF OF CEMENT-TILE HOLLOW SLABS

necessity for interior wood sheathing, painting or plastering, and exterior covering is required only on flat roofs. The tiles interlock and are self-fastening, and adjust themselves to slight variations in the steel framing. They are not affected by gases or acid fumes. The glass-insert tiles provide for ample roof light without the use of ordinary skylights and metal framing. The tiles have been used extensively on factory and mill buildings, car sheds, warehouses and other structures.

The Government Nitrate Plant

Congress has authorized the President to proceed with the construction of a Government nitrate plant and appropriated $20,000,000 for the work. The act of authorization gives the President a free hand in arranging for the design and construction, except that the plant must be built and operated solely by the Government and not in conjunction with any other industry or enterprise carried on by private capital.

Recent events are likely to cause work upon this enterprise to be undertaken with all possible speed. The two things to be done first will be the selection of a suitable water power at which to erect a plant and of the process to be used in nitrate manufacture. It is likely that a site on some river in the South will be chosen.

With reference to the various processes for the fixation of nitrogen, while a great deal has been published recently concerning the commercial development of nitrate production in Norway and in Germany, American engineers should remember that the first commercial production of nitrate from atmospheric air by electric current was made at Niagara Falls in 1901 by the process invented by Charles H. Bradley.

It had been known from the very early days of chemistry that under the intense heat of an electric arc it was possible to cause a combination of the nitrogen and oxygen in the air. Bradley was the first, however, to work out a commercial process of accomplishing this in such a manner that the product could be utilized.

The work at Niagara Falls carried on by Bradley and Lovejoy, while a success technically, was a failure financially. Under ordinary conditions, nitrate products made by the electrical process must compete in the market with those made from the imported Chilean nitrate. Numerous syndicates which have carefully investigated nitrate production in this country during the past decade have been unable to figure out a sufficient profit in the artificial nitrate industry to make the establishment of a plant a particularly attractive financial proposition. In Europe, on the other hand, with cheaper labor, cheap power at the great waterfalls in Norway, and an enormous market for nitrate both for use in fertilizers and for the manufacture of chemicals and explosives, the nitrate industry has had a rapid development.

According to a review of the various nitrate processes now in use, published in the *Engineering and Mining Journal* of June 17, the Pauling process, which operates on a somewhat similar principle to the Bradley and Lovejoy process, is utilizing more than 200,000 electrical horsepower in Norway at the present time, while further additions in hand and contemplated will bring the total power consumption to about 500,000 hp. Another process, of which more has been heard in this country, is the treatment of calcium carbide with atmospheric nitrogen when calcium cyanamid is produced. This product may be used directly as a fertilizer or as a basic material for the manufacture of ammonia or cyanide. It has been authentically reported that there are 16 cyanamid plants in operation in the world, of which four are in Germany, three in Italy, two in Switzerland, one each in Norway, Sweden, France, Japan and other countries. One of these is a plant in Canada—that of the American Cyanamid Co., described in *Engineering News*, Jan. 7, 1915.

Another process, the Serpek, works through the combination of certain metals and metalloids with nitrogen. It is claimed that a German inventor has succeeded in making aluminum nitride with an amount of electric energy only one-eighth of that required for the electric-arc process and one-half that for the cyanamid process. The process may also be used to produce pure alumina for the manufacture of aluminum. Another German process is the Haber process, in which ammonia is produced by the union of hydrogen and nitrogen direct. This is said to be such a commercial success that German capital has been withdrawn from the Norwegian plants for investment in the Haber process, which does not require cheap power. The *Engineering and Mining Journal* states that the Southern Aluminium Co., which is building a very large water-power plant at Whitney, N. C., for the manufacture of aluminum, plans to start the manufacture of alumina by a thoroughly commercial process and then to change over unit by unit to the Serpek process, in which aluminum nitride is formed from bauxite and decomposed to form ammonia and alumina.

Military Ponton Bridges Used in the United States Army

By Percy E. Barbour*

SYNOPSIS—Outline of the standard equipment prescribed by United States Army regulations and now carried by the regular army and by the militia units.

When a river is more than 4 ft. deep or when its bottom is of mud or quicksand, it is considered unfordable and recourse must be had to ferrying or to military bridges; a ponton[1] bridge may be placed when a stream is more than 2 ft. deep.

The standard bridge equipage used by the United States Army is of two types, heavy and light. The heavy type, carried on wagons known as the reserve train, enables bridges to be built sufficient for all requirements of an army on the march. The reserve train is mobile enough to move at the ordinary rate of marching and accompanies the main body of troops. In the light equipage, capacity is sacrificed somewhat for the sake of further mobility to enable a bridge to be carried with a rapidly moving column of light troops, such as advance guards, cavalry expeditions, etc.

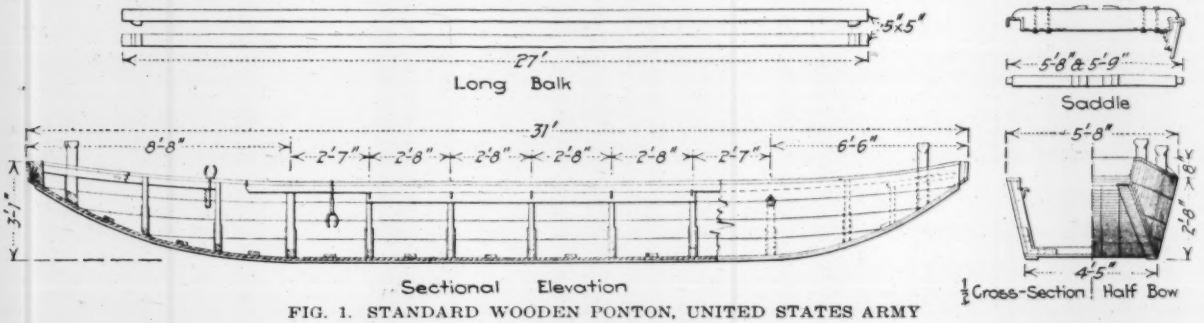


FIG. 1. STANDARD WOODEN PONTON, UNITED STATES ARMY

The principal parts of a military bridge are the pontons, or boats; the longitudinal bars, or stringers, joining them, called balks; the crossplanks, called chess; and the beams that hold the chess in position, called side rails.

The pontons carried by the reserve train are complete wooden boats, Fig. 1, and are transported on wagons. Each boat weighs 1,600 lb., has a displacement of 9½ tons and will carry 40 men armed and fully equipped—a total weight of about 9,300 lb. When assembled as part of a bridge, the supporting power is rated considerably lower; and with a factor of safety of 4 and a distance between supports of 14 ft. 4 in., the uniform safe load is 9,500 lb., or 660 lb. per lin.ft. The corresponding concentrated load in the center is 4,750 lb., which is about the weight from one axle of a 5-ton wagon and load.

The pontons for the light equipment carried by the advance-guard train are canvas boats and are constructed at the point where needed, the material being carried by the train. The canvas ponton weighs 510 lb., has 6 tons' displacement and will carry 20 men fully equipped and its crew. The floor system used with this light ponton has nine-sixteenths the strength of the heavy floor for concentrated loads, but an equal capacity for uniform loads because the span between the pontons is shorter.

The canvas for the ponton is carried in a wooden box and is shown laid out flat on the ground in Fig. 2. It is made of 0000 cotton duck, double

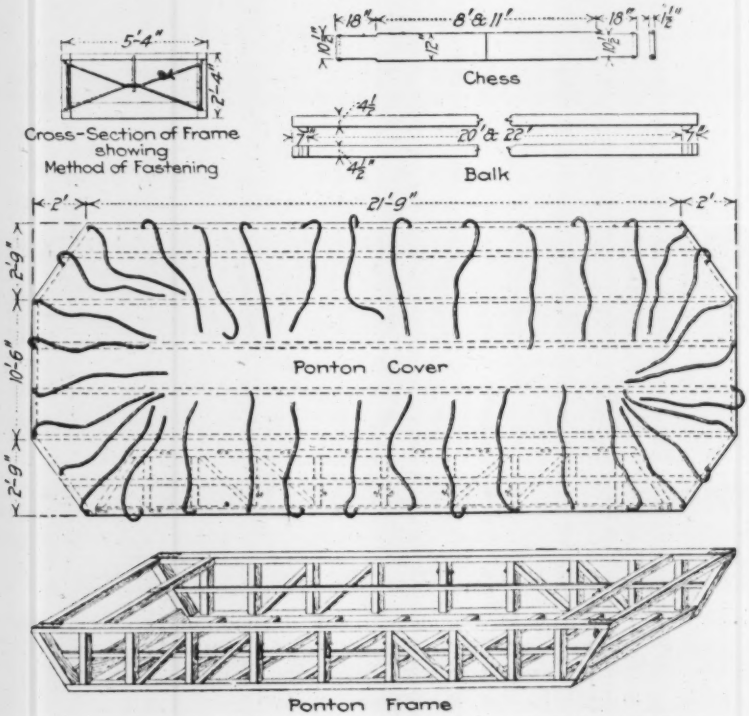


FIG. 2. STANDARD CANVAS PONTON, UNITED STATES ARMY

*First Lieutenant, 22nd New York Engineers on United States field service, on duty at McAllen, Tex.

[1]Although pontoon is a common spelling of this word, the French spelling, ponton, is used in all United States Army publications and most scientific works.

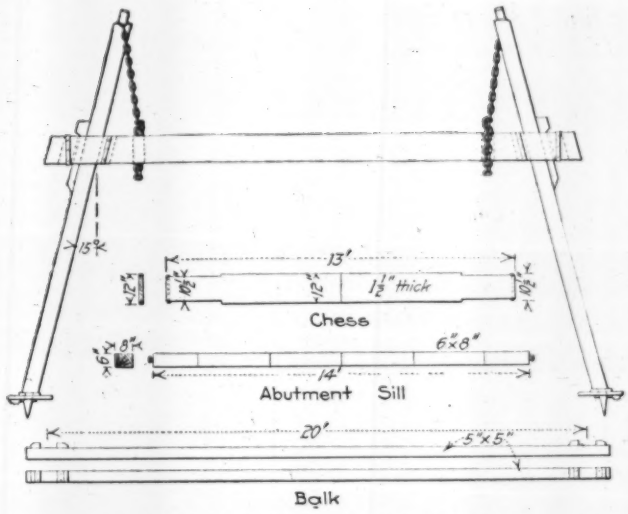


FIG. 3. STANDARD APPROACH TRESTLE

seamed, with the border doubled for 1½ in. in width. The clew-line eyelets are of metal. The clew-lines are $\frac{7}{16}$-in. diameter manila rope 5 ft. long.

In assembling the canvas ponton the canvas cover is laid on the ground, and one of the side frames is laid on it. In this side frame are mortises, into which are inserted the tenons on the transoms, or crosspieces, of which there are 14. The second side frame is next placed, a rope is passed through the rings of the side frames, made fast and twisted with a rack stick to hold the ponton frames together. The frame is turned over on the canvas, and the cover is lashed first on both sides and then on both ends. The ponton is now ready to be launched. As it is very light, it need not be built at the water's edge, but can be easily carried a considerable distance by six or eight men. The ponton is provided with a 75-lb. kedge anchor, 30 fathoms of 1-in. manila rope, boat hooks, paddles, etc.

Trestle Approaches to Ponton Bridges

As the canvas ponton, after having been launched, should never be allowed to touch the bottom, it will be necessary to use a trestle approach at the ends if the water near the bank is shoal. The structure used is what is known as the Birago trestle, shown in Fig. 3. This trestle consists of two legs, a trestle cap, two pieces of ⅝-in. chain, shoes, pins and sundries. The trestle is assembled on the ground after the determination of the proper depth of water to enable the placing of the trestle cap at the proper height, where it is held by the chains and the small false legs used as keys. The trestle is set up in a vertical position and held by guys. An abutment sill is embedded in the ground at the approach to the bridge, at right angles to its axis, and is secured by four pickets or stakes.

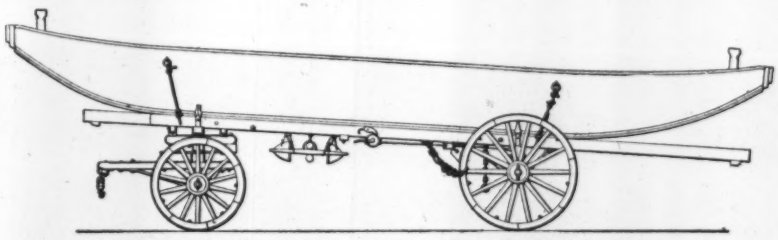


FIG. 4. STANDARD WAGON FOR RESERVE TRAIN

Balks are laid from this abutment sill to the trestle cap, the first ponton is brought into position beyond the trestle, and balks are laid from the trestle to the ponton. Successive pontons are brought up and balks are laid between them, the chess, or crossplanks, are placed, and the side rails are laid on them.

Fig. 4 shows the wagon and method of transporting the wooden and canvas pontons. The load of the ponton wagon for the heavy train is 2,900 lb. and the weight of the wagon 2,200 lb., making the total load 5,100 lb. A team of six to eight animals is used. The load of the canvas-ponton wagon is 1,985 lb.; the wagon weighs 1,750 lb., making a total load of 3,735 lb. Four to six animals are used. The other wagons in the train have lighter loads respectively, except the trestle wagon of the light train, which has a total weight of 3,810 lb.

Both the heavy and the light trains are composed of four divisions each. In the heavy train each division carries material sufficient to construct a bridge 225 ft. long, having 11 bays. The complete equipage of this train weighs, wagons included, 315 lb. per ft. of bridge; not including wagons, 169 lb. per ft. A division of light equipage will construct 186 ft. of bridge. The entire equipage, including wagons, weighs 275 lb. per ft. of bridge; without wagons, 128 lb. per ft.

Ponton bridges have been successfully constructed across streams 2,000 ft. wide and so deep and rapid that the pontons could not be held by their own anchors, so that it was found necessary to attach cables to schooners anchored above and below the bridge to hold the pontons in position.

When such a bridge has to be constructed over a navigation channel, it is comparatively easy to construct a drawspan that can be opened and closed by slacking off the upstream cable and allowing the drawspan to drift down with the current and be swung around out of the channel. Where wide draws are required, the drawspan may be in two parts, one swinging on each end of the bridge. Military trestle bridges are applicable only to shallow rivers with firm bottom and no likelihood of sudden change in water level. On a rocky bottom they are difficult to construct, on a soft bottom they sink, and on a sandy bottom they undermine, so that for a quickly built structure for the use of troops ponton bridges are far preferable.

The American ponton-bridge equipage was designed, in practically its present shape, by a board of engineers sitting just before the Civil War. They incorporated various features of military-bridges found abroad and adapted the pontons to mule-wagon transportation. Their great success was immediately demonstrated in 1861-65. The mules themselves are an important factor in ponton-bridge work and have to be trained for the service. The quartermaster's department is not relied on for transportation. Motor trucks may be utilized at times but they usually cannot approach the banks of the stream to be crossed so that the mules are generally required.

Hydraulic-Fill and Wheeled-Scrapers for Levees

SYNOPSIS—Details of special construction on a modern, large size drainage project.

The reclamation of the low-lying and wet lands within the St. John Levee and Drainage District, in the southeast section of Missouri, will be effected by means of levees to exclude flood water and ditches to carry off the surface water. This project, which must provide for an area of about 425,000 acres, was reviewed in *Engineering News*, Sept. 17, 1914. Work is now in active progress.

A levee along the entire river front of the district, from above Bird's Point to the City of New Madrid, Mo. (about 90 mi.), is being built by the United States Government. Very large drag-scraper excavators are being used for this work, as described in *Engineering News*, May 25, 1916. It will be some years before this is completed, however, and in order to secure early protection for New Madrid and the comparatively high ground to the north of the city, the District is now building a levee extending along

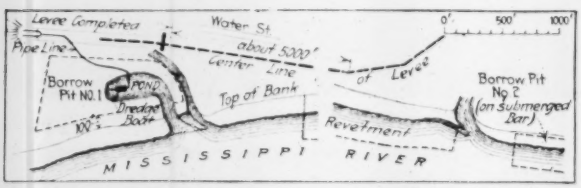


FIG. 1. PLAN OF THE HYDRAULIC-FILL LEVEE AND CONSTRUCTION PLANT AT NEW MADRID, MO.

the river front of the city for about a mile, and then north about 10 mi. to Farrenburg. It is building also a ditch extending east and west to connect the Black, James and St. John bayous, and so carry off flood waters. There will be also an extensive series of drainage ditches throughout the district, aggregating 200 mi.

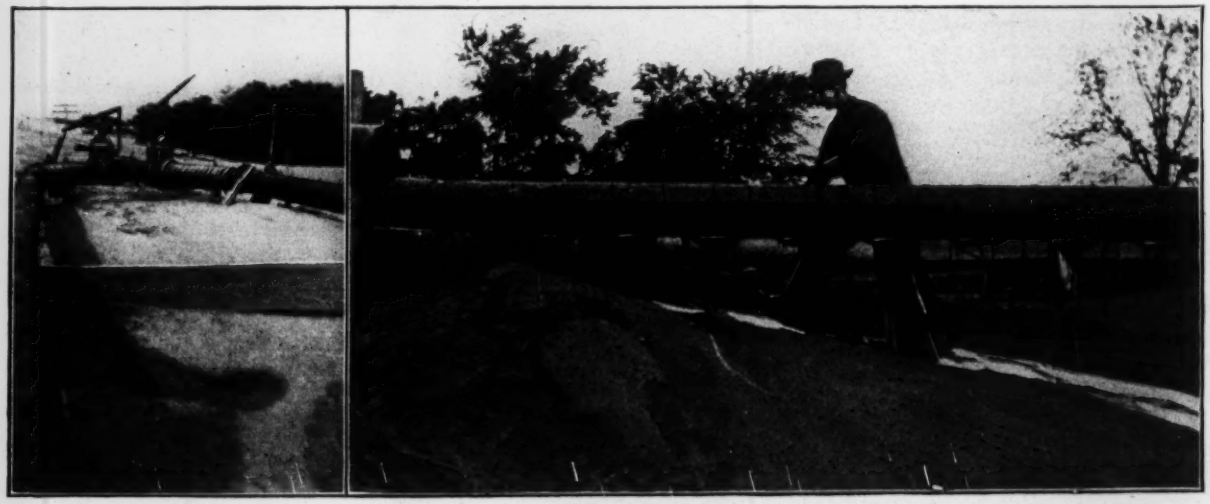
The completion of the Government levee along the river front (a few years hence) will close the St. John's outlet south into the Mississippi, just east of New Madrid. Plans to provide for this have been considered. Flood gates may be placed to pass the drainage water or a pumping station may be built, but the latter would be expensive in construction and maintenance. Another plan, is to close the river outlet altogether and to extend the main ditch westward behind the city and through the slight rise known as the Sikeston ridge to connect with the ditch system of the adjacent Little River drainage district.

The chief engineer for the district is Charles H. Miller, of Little Rock, Ark.; C. V. Hansen, of New Madrid, Mo., is Assistant Engineer in direct charge of all the work. The work now under construction includes the following: Hydraulic-fill levee, 1 mi. long, 250,000 cu.yd. at 20c. per yd.; the Hillsboro Dredging Co., Tampa, Fla. Earth levee (teams and scraper), 10 mi. long, 500,000 cu.yd., at 13½c.; A. B. Hunter, New Madrid, Mo. Main ditch, 23 mi. long, floating dipper dredge work, 1,800,000 cu.yd. at 5.38c.; A. V. Wills & Sons, St. Louis, Mo. Most of this work is to be completed during 1916. Major Markham, U. S. Corps of Engineers, at Memphis, Tenn., is in charge of the river-front levee for the district.

Hydraulic-Fill Levee

The levee which extends along the river front for about a mile at New Madrid, Mo., is being built of sand pumped into place. This levee will be on top of the present river bank, the site being cleared, all stumps blown out with dynamite, and some buildings razed.

The present bank has a stone revetment, placed by the U. S. Government. The United States Engineers in charge of this district would not permit sand to be pumped from the river below the downstream end of the revetment, and required the borrow pit to be at least 100 ft. from the river. At the upstream end, however, the dredge boat will be in the river, and will take sand from a partly submerged bar, with a discharged line on pontoons to the shore delivery pipe. (For locations see Fig. 1.)



FIGS. 2 AND 3. PIPE LINE ON HYDRAULIC-FILL LEVEE AT NEW MADRID

Fig. 2—Double discharge pipes on end of delivery pipe, showing regulating valve on each pipe. Fig. 3—Discharge pipe with bottom openings fitted with slides

For the present work at the borrow pit (south of the city) the dredge boat cut its own channel from the river to the site of the pit, and is now working in a pit which may be excavated to a depth of 30 to 40 ft. It is enlarged simply by undermining the sides with the sand suction pipe and allowing the material to cave in. This pit will remain permanently, to serve as a storage pond for logs for a sawmill company. On this condition the company donated the right-of-way for this part of the levee. As the levee will occupy the present location of a public road, a new road has been built along the land side.

The dredge boat is a timber barge, about 80x26 ft., 5 ft. deep, equipped with a Fairbanks gasoline engine of 80 hp. and a 10-in. centrifugal pump. The hinged sand suction pipe is of Z-shape and is raised out of the water when the pump is required to deliver clear water as for cleaning out the pipe. The discharge pipe is carried by pontoons in the borrow pit and connects to the shore discharge pipe. It was considered that this pump should be able to deposit 1,000 cu.yd. of sand in 12 hr., and this record has been reached. The material is mainly river sand, with some pebbles, and occasionally some mud or earth. The discharge contains about 10% solid matter. Work is carried on continuously day and night, except on Sundays.

The shore discharge pipe is 10-in. spiral riveted pipe in lengths of about 18 ft. with telescoped joints. Its

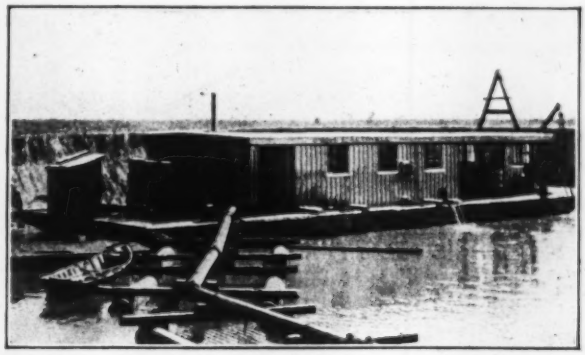


FIG. 4. DELIVERY END OF DREDGE WITH PIPE ON PONTOONS

maximum length for direct discharge from the pump is about 1,500 ft. For the greater distance required when pumping from the sand bar, a booster pump will be placed at 1,500 ft. and then the material can be delivered 3,000 ft. farther, or 4,500 ft. from the dredge boat. The pump can keep the 10-in. pipe full.

This shore pipe sometimes gets choked with sand, and has then to be cleaned out by pumping clear water through it. This necessitates signaling between the point of discharge and the dredge boat. The sand suction pipe is controlled by a man in a cabin on the boat, and at a point near the discharge on the fill is erected a signal within his view. This is a post with a long arm pivoted near the top to swing in a vertical plane; one end carrying a red flag and lamp, the other a white.

The discharge pipe ends in a Y-branch with two parallel pipes each fitted with a gate valve. One pipe is in service while the other is closed for shifting and extending. The last section on each branch is a pipe with numerous bottom openings fitted with slides. The end of the pipe is supported on a crosspiece nailed to two stakes embedded in the fill, and the discharge flows through a steep trough or chute to the surface of the fill. On either side is a line of boards (about 12 ft. apart) to limit the flow to the central part of the fill, and along these are wings or baffle boards, which are shifted inward as the fill rises. Views of the work are shown in Figs. 2 to 5.

The wet sand packs so solid that no allowance is made for shrinkage. The best results are obtained by building up the central part of the fill to grade, and then letting it spread on either side. If it is attempted to fill to the entire bottom width first, a large amount of material is wasted, as the flow is not so easily controlled. The water escaping from the fill is led to a ditch on the land side of the levee, and flows to one of the drain culverts, beyond which it finds its way back to the borrow pit. This ditch becomes lined with the finer material and will be cleaned out before being covered by the fill. The completed fill will be sown with bermuda grass.

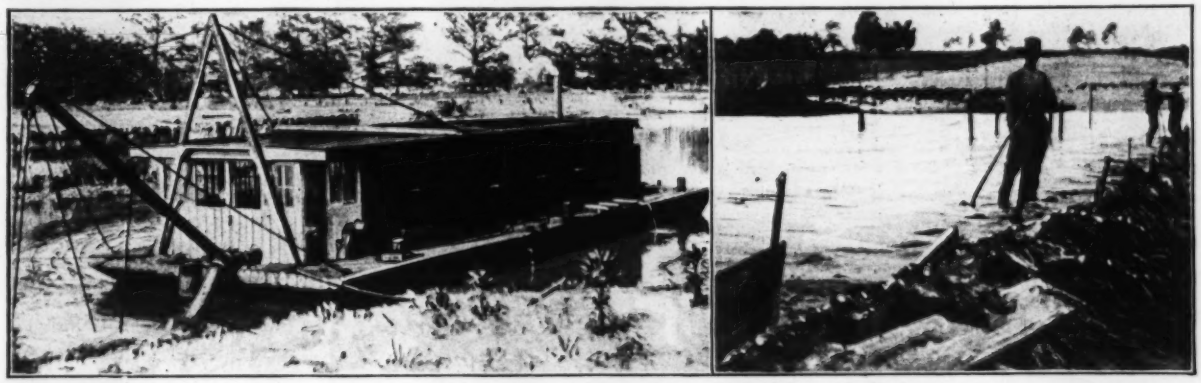


FIG. 5. SUCTION END OF GASOLINE-HYDRAULIC DREDGE, AND BAFFLE BOARDS ALONG SIDES OF FILL

At the lower end of the levee five residence buildings have to be raised about 10 ft. to the new elevation, and will be placed on concrete foundations. The 10-ft. crown of the levee will be on the river side of the buildings, forming a public path.

At intervals there are reinforced-concrete culverts to carry off drainage water from the land side of the levee. These are rectangular box culverts 3x3 ft. with flap valves to close against flood water. The valves are operated by chains in square concrete manholes which extend to the top of the levee. There will be also four sewer outlets, of 4- to 10-in. pipe. Each of these will be embedded in concrete, forming a rectangular box 6 in. thick. Vertical

slide gates will close these against flood water, the gates being operated through manholes.

The levee now being built north of the city will be about 10 mi. long, extending from the river to Farrenburg. It is being built by wheeled scrapers, the material being mainly a heavy red earth, containing very little sand. This is taken from borrow pits on the outer or water side. These are kept not less than 30 ft. from the toe of the slope, and rarely exceed 3 ft. in depth.

The levee has a crown width of 8 ft. with 1 on 3 slopes. An allowance of 15% is made for shrinkage, the top being filled 15% higher than grade line. The maximum height is about 18 ft. Where the levee makes a right-angle turn in leaving the river to run north, a spur is run out from the corner, to prevent water from running against it and causing erosion. The site of the base of the levee is cleared and plowed, to insure a bond, and all stumps are blown out with dynamite. No muck ditch under the levee is considered necessary, though this was proposed originally. On the land side is a berm of 20 ft., except that where a road is built along the levee berm this width is made 35 ft.

Along the edge of this inside berm is a ditch to intercept drainage water. At intervals of about a mile are reinforced-concrete box culverts to carry this water through the levee. The culverts are from 18x18 in. to 36x36 in., with an apron and wing walls at each end, and a cutoff wall or collar near the middle to prevent water from working through the fill along the concrete face.

In each culvert is a Coffin flood gate of the hinged flap-valve type, closing automatically against flood water but normally held open by a chain passing up a manhole. For culverts 18x18 in. the manholes are of 12-in. sewer pipe; those on larger culvert are of brick. The flood gates are circular, as no square gates were in stock, and would have been expensive if made specially. The concrete at the gate chamber is rounded to fit the circular opening of the gate. The culverts have a grade of 3%, so that the rush of water will make them practically self-cleaning. At the inlet end is a simple grating.

The contractors for this levee are working from 19 to 28 wheeled-scrapers of ½-yd. capacity, with two-mule teams. For each three scrapers there is a three-mule snap-team to help the scraper teams while loading. Two plows with two-mule teams break up the ground to make the loading easier.

Besides the team drivers there are a straw boss and dump man at the dump, a loader for each three scrapers at the borrow pit, and a man to handle each plow. This crew works about 12 hr. per day. With this outfit there is placed 30,000 to 40,000 cu.yd. per month.

Main Drainage Ditch

The main ditch, which will carry off flood waters, will be about 25 mi. long, from Black and James bayous to St. John Bayou, entering the Mississippi just east of New Madrid. This ditch and all the drainage ditches will be excavated by floating dipper dredges having 2½- to 5-yd. dippers. The excavation will be mainly in heavy black gumbo or buckshot, which is expected to stand well in the slopes. The main ditch will have a bottom width of 30 to 70 ft., a water depth of 8 ft., and side slopes of 1:1, with a 15-ft. berm and a spoil bank on each side. For this ditch a right-of-way 250 to 350 ft. wide is cleared. The trees are cut at a height of about 3 ft., except that on the berm they are cut at about 18 in.

Grade-Crossing Elimination at Memphis Bridge Terminals

By J. H. Weatherford*

The year 1916 will see the completion of the new $5,000,000 railroad and free highway bridge now being built over the Mississippi River at Memphis, Tenn., by the Arkansas & Memphis Railway Bridge and Terminal Co. This bridge in addition to carrying a double-track railway between the trusses, has a double roadway for vehicles carried on cantilever brackets outside the trusses on each side. The bridge parallels the present single-track bridge of the St. Louis & San Francisco Railroad Co. and is only 200 ft. upstream therefrom. This bridge will not only provide more adequate railroad facilities, but it will be the only highway bridge across the Mississippi River south of St. Louis.

Extensive railroad yards and track approaches on the eastern side of the river made necessary a number of grade separations of both the old and the new bridge tracks from the city streets. As originally planned, these grade separations would have required extensive lowering of streets to permit the separation of the grade of Pennsylvania St. from the St. Louis & San Francisco R.R. In an endeavor to avoid the expense and damage resulting, the track-diversion plan shown in Fig. 3 was suggested by the writer and worked out by the engineers of the St. Louis & San Francisco R.R.

FIG. 1. INDIANA ST. SUBWAY, SHOWING CONSTRUCTION OF I-BEAM FLOOR

This new plan involves the abandoning of approximately 3 mi. of track and the substitution therefor of about 2 mi. on a new location, with the net elimination not only of a mile of track but also of nearly fifty crossings. In carrying out the work the tracks are to be raised a maximum of about 10 ft., and this work is now well under way.

Fig. 3 also shows joint subways being built by the bridge company and the Rock Island Railroad Co. at Indiana St. and at Pennsylvania St. and a separate subway being built by the Frisco R.R. at Pennsylvania St.

Three other subways under contract between the railroads and the city, one at Florida St. and Railroad Ave. and a double subway where Carolina Ave. crosses the Frisco and Iron Mountain tracks are also affected by the changes in alignment and grade. The double subway at Carolina Ave. is shortened to about half its original length and the street depression is greatly reduced.

*City Engineer, Memphis, Tenn.

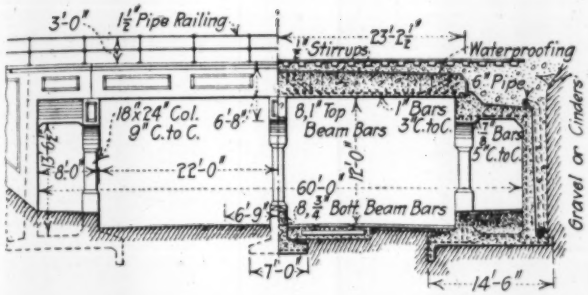


FIG. 2. TYPICAL END ELEVATION AND CROSS-SECTION OF CAROLINA AVE. AND FLORIDA ST. SUBWAYS

Tracks spaced 12½ ft. c. to c. Four floor slabs per track, each 6 ft. 2½ in. by 23 ft. 2½ in. Designed for Cooper's E55 loading. Impact, 50% of live-load.

Quantities per lin.ft. of subway:

Slab floor system	4.74 cu.yd.
Abutments	4.87 cu.yd.
Center supports	0.98 cu.yd.
Total	10.59 cu.yd.
Wing walls (right angle 20 ft. long), each	26.81 cu.yd.
Reinforcement of slabs	173 lb. per yd.
Reinforcement of substructure	140 lb. per yd.

All concrete 1 : 2 : 4.

Fig. 2 shows a typical end elevation and section of the subways at Florida St. and at Carolina Ave. except that the total width between abutments on Carolina Ave. will be 65 ft. The design is especially noteworthy on account of the extensive use of reinforced concrete and of the box type of abutments, a feature designed by W. F. Schultz, Chief Engineer on these subways. Street grades on the subway approaches will be approximately 4% and the paving will be of vitrified brick on a concrete foundation.

These two subways, exclusive of paving, but including property damages will cost approximately $175,000 of which the city's expense will be approximately $25,000 plus the cost of paving.

The Pennsylvania St. subway will be 80 ft. wide between abutments, with 50-ft. wide roadway. The columns are located on the curb line and in the center of the street and the subway will be 356 ft. long from portal to portal. The abutments are of gravity type with reinforced sidewalk slabs and I-beams encased in concrete for the roadway slabs, following the usual design.

The Frisco subway crosses Virginia Ave. and Pennsylvania St. intersection and will be a double-track through girder structure with columns on the curb line and short sidewalk spans. The main span will be 79 ft. 6 in. with two end spans of 21 ft. each and gravity-type abutments. The girders are to be encased in concrete and the floor will be a concrete slab.

The Indiana St. subway will have gravity type abutments and a single 24-ft. span of I-beam construction encased in concrete. Fig. 1 shows the I-beam floor of this subway being placed and Fig. 4 shows a longitudinal section and elevation. The north 24 ft. of Virginia Ave. will be depressed as shown in Fig. 4, the remainder of the street being separated from the depressed portion by a gravity-type retaining wall. The subway is designed to carry one-way traffic only and will be exclusively used for west-bound traffic over the Arkansas and Memphis bridge.

One of the features in connection with the work will be the moving of a two-story and basement brick building, one of the city public schools, about 200 ft. away to a new location.

The expense of the subways and bridge approaches, now being constructed, will be approximately $700,000 including property damages and paving, all of which, except a minor portion of the paving will be borne by the railroad companies. In addition approximately $550,000 will be expended by the Rock Island Railroad Co. in building new yards.

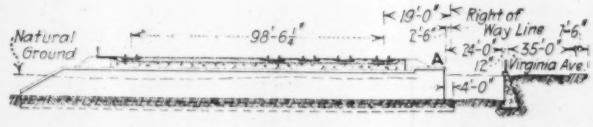


FIG. 4. LONGITUDINAL SECTION OF INDIANA ST. SUBWAY

The work is in charge locally of K. G. Williams, Resident Engineer representing F. G. Jonah, Chief Engineer, St. Louis & San Francisco (Frisco) R.R., C. A. Morse, Chief Engineer, Chicago & Rock Island R.R. and C. D. Purdon, Chief Engineer, Cotton Belt R.R. The interests of the City of Memphis are in the hands of the writer.

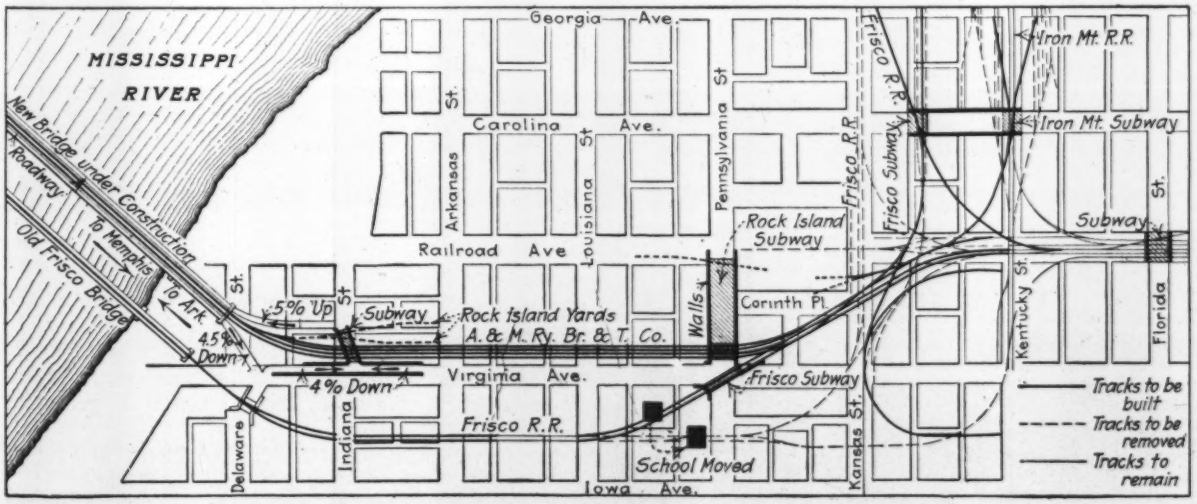


FIG. 3. MAP OF STREETS AND RAILWAY TRACKS AT EASTERN TERMINAL OF RAILWAY BRIDGES ACROSS THE MISSISSIPPI RIVER, MEMPHIS, TENN.

Showing track and street changes for grade-crossing elimination

Lagscrewed Joints in Timber

By H. D. Dewell*

SYNOPSIS—Results of tests made in connection with the Panama-Pacific exposition wooden frame buildings.

Among the new tests of timber joints made by the writer on the Panama-Pacific exposition last year were 14 joints fastened by lagscrews. The tests on bolted joints and the conclusions as to safe practice in design were reported in *Engineering News* of July 20, 1916. The present article covers the lagscrew tests.

Of the 14 tests, 4 were on joints in which a ½-in. steel plate was fastened to a timber block, and 10 were on joints in which wooden plates, 1¼ in. to 2 in. in thickness, were lagged to an 8x8-in. block. The detail

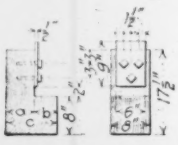


TABLE OF DIMENSIONS, LAGSCREW JOINTS, TYPE S-T

Joint Number	Size of Lagscrew	a	b	c
7	¾x4½ in.	6 in.	4 in.	10 in.
8	¾x4½ in.	6 in.	4 in.	10 in.
9	⅞x5 in.	7 in.	5 in.	12 in.
17	⅞x5 in.	7 in.	5 in.	12 in.

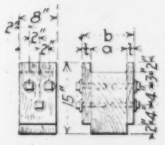


TABLE OF DIMENSIONS, LAGSCREW JOINTS, TYPE A-T-E-B

Joint Number	Size of Lagscrew	t	a	b
A	⅞x5½ in.	2 in.	8 in.	12 in.
C	¾x4½ in.	1¼ in.	8 in.	10½ in.
D	⅞x5½ in.	2 in.	8 in.	12 in.
F	¾x4½ in.	1½ in.	8 in.	11 in.
G	⅞x5½ in.	2 in.	8 in.	12 in.
H	¾x4½ in.	1⅜ in.	8 in.	10¾ in.

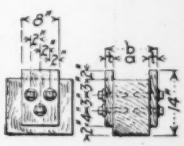


TABLE OF DIMENSIONS, LAGSCREW JOINTS, TYPE A-T-C-B

Joint Number	Size of Lagscrew	t	a	b
B	⅞x5½ in.	2 in.	8 in.	12 in.
E	⅞x5½ in.	2 in.	8 in.	12 in.
I	¾x4½ in.	1⅜ in.	8 in.	10¾ in.
J	¾x4½ in.	1⅜ in.	8 in.	10¾ in.

FIG. 1. DETAILS OF TEST JOINTS MADE UP WITH LAGSCREWS

makeup of these joints is shown in Fig. 1. Some of the stress-deformation curves secured in the tests are shown in Fig. 4.

An autographic testing-machine record was taken in all the tests in addition to the direct readings of slip; with joint 7 the autographic record only was made. In joint 9 the load was removed at 6,000 lb., when a slip of 0.05 in. had taken place. Here, as in the case of the bolted joints, there was some permanent set, although on again applying 6,000 lb. the deflection registered the same as before, or 0.05 in.

In testing the all-timber lagged joints the thread-and-card method was used throughout, so that the direct-reading curves represent the true slip of the joints. It will be noticed that the two curves—the direct reading and the autographic—follow closely together, but that the autographic curves always indicate a greater slip than the direct readings; this difference is undoubtedly due to end crushing.

In Kidder's "Architects and Builders Pocket-Book" there is published a table giving the resistance of lagscrews when used to fasten a metal plate to timber, the accompanying illustration showing the lags bearing against the ends of the timber fibers and subjected to shear. The method of arriving at the values given is not explained. A ¾x4½-in. lagscrew with a plate of $\frac{5}{16}$-in. minimum thickness is stated to be worth 2,100 lb. when employed with Oregon pine (Douglas fir); similarly the working resistance of a ⅞x5-in. lagscrew is given as 2,800 lb. Prof. H. R. Thayer states that lagscrews may be treated as bolts and their resistances for equal diameters assumed the same.

In the "Proceedings" of the American Railway and Maintenance-of-Way Association, Vol. 10, Part II, there is published a method for determining the safe resistance of a track spike to lateral displacement. This method is also given in Jacoby's "Structural Details." Referring to Fig. 3, the load P in terms of the maximum bearing stress s is

$$P = sdl^2/(4l + 6e)$$

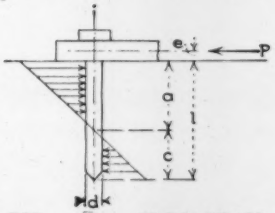


FIG. 3. DIAGRAM FOR LAGSCREW

Applying this formula to joints 7, 8, 9 and 17, assuming the diameter of the lagscrew to be constant and equal to the nominal diameter of the lag and using the limiting bearing stress of 1,300 lb. per sq.in., there is found for the case of the ¾x4½-in. lagscrew and ½-in. plate a safe resistance to lateral displacement of 770 lb. Similarly for a ⅞x5-in. lagscrew the safe resistance is 1,040 lb. The maximum flexural stress in the lagscrews is 10,700 lb. per sq.in. for the ¾-in. lag and 13,400 lb. per sq.in. for the ⅞-in. lagscrew.

For recommendations of Kidder and Thayer and values as derived from the foregoing formula see Table 1.

The author's previous tests on lagscrewed all-timber joints, in which ¾x4½-in. lags were used in fastening 2-in. planking to 12-in. blocks, with the screws bearing

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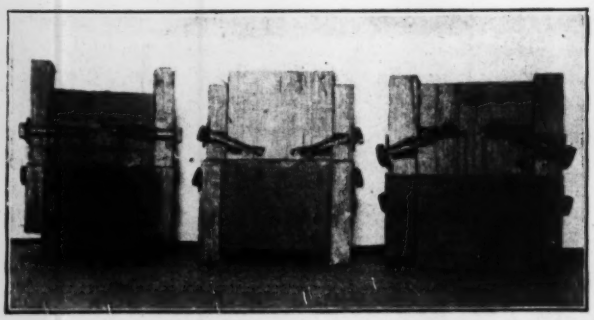

FIG. 2. THREE OF THE LAG-SCREWED JOINTS AFTER TEST, CUT APART

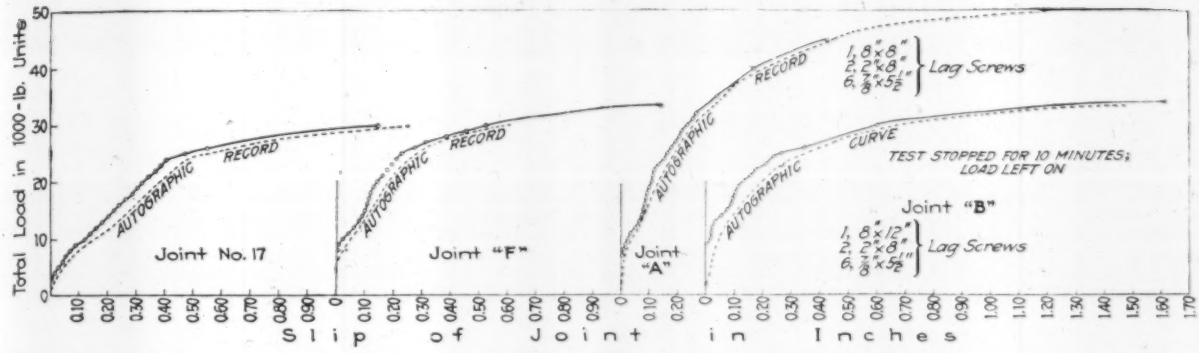

FIG. 4. TYPICAL LOAD-SLIP CURVES FOR LAGSCREWED JOINTS

against the fibers of the planking and across the fibers of the block, showed the average ultimate strength of a lagscrew in this joint to be 4,187 lb. No detail measurement of slip was made, but it was noticed that the first movement appreciable to the eye occurred at an average load of 2,423 lb. and was approximately $\frac{1}{16}$ in. to $\frac{1}{8}$ in. in amount.

TABLE 1. STRENGTH, IN POUNDS, OF LAGSCREWS FASTENING STEEL PLATES TO TIMBER

	¾x4½-In. Lag	⅞x5½-In. Lag
Kidder	2,100	2,800
Thayer	1,125	1,575
Theoretical	770	1,040
Tests*	770	900
Tests†	975	1,300

*One-half the values for limiting deflection of $\frac{1}{16}$ in.
†Values for deflection of $\frac{1}{32}$ in.

Discussion of Tests

The test results show that: (1) For loads up to 2,000 lb. per screw the strength of a ⅞-in. lag is not appreciably larger than that of a ¾-in. lag; and (2) the working values as given by Kidder correspond to a slip of 0.08 in. for the ¾-in. screw and 0.12 in. for the ⅞-in. lagscrew.

Possibly the strength of the lagscrews as shown by these four tests is low, since there was some bending of the plates and a consequent tension in the upper screws. However, this condition could not have existed in the earlier stages of the tests.

Using the limiting deflection of $\frac{1}{16}$ in. as in the case of the bolted joint, with a factor of two for working loads, it is seen that the safe working resistance of a ⅞-in. lagscrew in such a joint (a thin steel plate lagged to timber) is one-half of 1,800 lb., or 900 lb. For consistency the corresponding resistance of a ¾-in. lagscrew may be taken at 770 lb. (proportional to the respective diameters, since bearing and not bending determines the working resistance). Similarly for a limiting working slip of $\frac{1}{32}$ in. the capacity of a ⅞-in. lagscrew is 1,300 lb. and a ¾-in. lag 975 lb. These values are in accordance with those found previously by the theoretical method.

On comparing the curves of the lagscrewed all-timber joints with those of the bolted joints it is evident that, while the ultimate strength of the former is far below that of the latter for the same diameter of lag or bolt, the lagscrewed joints are stiffer for the same load, up to the break in the curve.

An examination of the joints cut open shows some interesting points. The lagscrews have evidently been subjected to much less bending than the bolts; indeed, in some cases no bending is apparent. They have, however, resisted tension, which the wood was unable to withstand, as is evidenced by the partial withdrawal of the lag. The reflex bending noticed in the bolts is almost entirely lacking, and the distribution of pressure exhibited by the crushing of the timber fibers is different from that of the bolts.

In addition to the moments produced by the pressures here shown there exists a couple, formed by the pressure of one side of the washer against the timber and a corresponding pull of the threads of the screw on the main block. Whether this condition exists in the early stages of the test, it is not possible to state. A theoretical consideration of the problem was considered, but was abandoned on account of impracticability.

The superior stiffness of these joints over the bolted joints, for loads up to 3,000 lb., may be accounted for in part by the tight fit of the lagscrews in the timber and by the binding action of the tightly drawn washers, producing both friction between the timbers and restraint in the bending of the lags, although it is believed that the friction of the joint is a negligible quantity.

As in the case of the bolted joints, there seems to be practically no reduction in stiffness for the ⅞-in. joints, in which the lagscrews bore across the fibers of the timber in the main block. This statement holds true only for loads of approximately 2,000 lb. per lagscrew. In ultimate strength such joints are far below those having all end bearing; the failure is sudden and due to splitting of the main timbers.

Fig. 5 gives curves showing the average strength of the joints with each size of lagscrew and also the average strength of the individual lagscrews, with the corresponding deflections. With the criterion of a working strength of one-half the load corresponding to a slip of $\frac{1}{16}$ in., the safe resistance of a ¾x4½-in. lagscrew may be taken

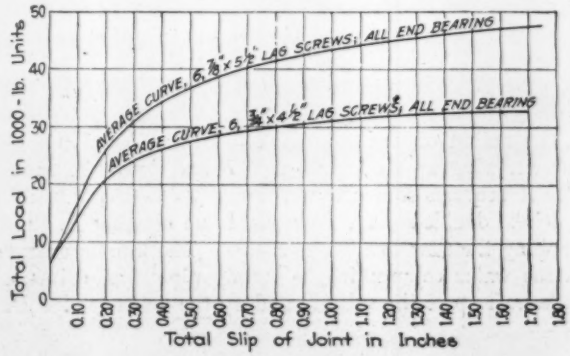
Total Load in 1000-lb. Units
AVERAGE CURVE, 6, 7/8"x5 1/2" LAG SCREWS; ALL END BEARING
AVERAGE CURVE, 6, 3/4"x4 1/2" LAG SCREWS; ALL END BEARING
Total Slip of Joint in Inches

FIG. 5. AVERAGE LOAD-SLIP CURVES FOR LAGSCREWS

as 900 lb., while that of a 7/8x5-in. lagscrew may be taken at 1,050 lb. Similarly for a working slip of 3/32 in. the respective resistances are 1,375 lb. and 1,500 lb.

For joints in which a metal plate is fastened to timbers by means of lagscrews it is believed that the values of 900 lb. for a 7/8x5-in. lagscrew and 770 lb. for a 3/4x4½-in. lagscrew are reasonable working values and that 1,300 lb. and 975 lb. respectively should be the maximum allowable capacities used.

For all-timber lagscrewed joints similar to those tested the values of 1,050 lb. for a 7/8-in. lag and 900 lb. for a 3/4-in. lag are recommended for design, with a maximum of 1,500 lb. and 1,375 lb. respectively.

All working values advocated are for timber in a dry condition and for use in interior building construction.

The author wishes to express his appreciation of the kindness of Mr. Olsen, of the Tinius Olsen Co., for the use of his testing machine, and of E. L. Peck for operating the machine. Thanks are due C. E. Blee for assistance in making the tests and to L. F. Fulcher, under whose supervision the joints were framed. Especial acknowledgment is due A. W. Earl for many valuable suggestions in interpreting the results of the tests.

Siphon-Operated Hydraulic Ram of Long Standing

By H. S. Palmer*

While investigating the ground waters of certain parts of Connecticut in 1915, the writer's attention was called to a unique hydraulic ram owned by H. S. Parmelee, of Granby. The ram was patented Dec. 9, 1856, by Erastus W. Ellsworth, of East Windsor Hill, Conn. (letters patent, No. 16,176). The ram is so designed that it may be put at the crest of a siphon. The energy necessary to raise the water above the crest is the kinetic energy of the moving column of water in the siphon tubes. Mr. Parmelee's ram (see Fig. 1) is at the mouth of a dug well 7.7 ft. deep, containing 1.2 ft. of water (Oct. 25, 1915). The waste pipe discharges at a point 10.5 ft. below the mouth of the well, so that there is an effective head of 4 ft. The reservoir is on the second floor of the house, 15 ft. above the mouth of the well.

The ram (see Fig. 2) consists essentially of a rectangular chest with two inclined partitions, in which are openings, *I* and *K*, with flap valves, *C* and *D*. In the bottom there is a connection to the supply pipe *B*, and in the top two openings, *L* and *M*, leading to the waste pipe *A*, and the delivery pipe *H*, respectively. Between *L* and *A* and between *M* and *H* are two tubular air chambers. The key-shaped lever *J*, controls the rapidity of beat and also starts and stops the action; it is turned by a hand shaft passing through a stuffing-box in the back of the chest.

The action of the ram is as follows: A column of water flowing up the supply pipe *B* and down the waste pipe *A* acquires sufficient velocity to throw the valve *C*, which is double-acting, up against the opening *L*, thus stopping the flow to the waste pipe. The kinetic energy of the water column in the supply pipe then drives a little water past the valve *D* and up the delivery pipe *H*. When the motion is arrested and a reverse surge set up in the chest, the valve *C* falls from its upper seat and a new cycle is initiated by a flow of water through the siphon. Enough air is brought in through the supply pipe to keep the air chambers full.

When the siphon is empty it can be started, provided there is some water in the reservoir, by turning the key-shaped lever *J*, counterclockwise so that the peg raises the valve *D*. Water then flows from the delivery pipe, through the chest, and down into the waste pipe. When the waste pipe is full of water the valve *D* is allowed to drop. The water in the waste pipe produces a partial vacuum in the chest that raises valve *C* from its lower seat and draws water up the supply pipe. This action fills the waste pipe with air which is expelled by again opening the valve *D* with the key *J*, and allowing water to run down from the reservoir. Then with both legs of the siphon full of water the cycle of operations will commence automatically.

The front of the chest is a glass plate so that the operation of the parts may be observed. The rapidity of the beat may be regulated to some extent by means of the key *J*. When the key is turned close to the valve *C* the current of water trying to go down the wastepipe is concentrated and enabled to throw the valve against its upper seat more promptly, thus shortening the beat. This regulation is accomplished without actual contact between valve and key. The ram may be stopped by turning the key at the proper moment to hold the valve *C* against its upper seat until the surge in the chest has died out. With the legs of the siphon full of water all that is needed to put the ram in operation is to raise the delivery-pipe valve *D* a little by means of the key.

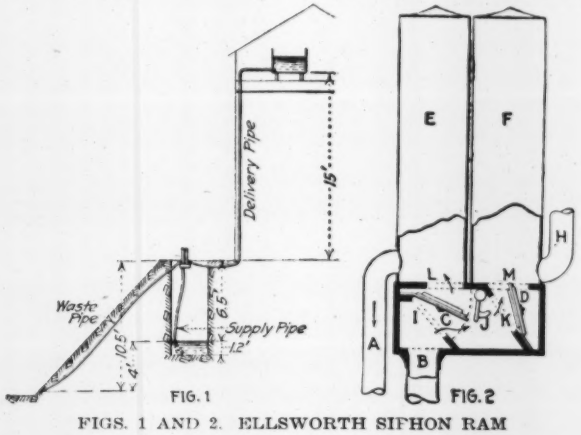

FIG. 1 FIG. 2

FIGS. 1 AND 2. ELLSWORTH SIPHON RAM

The siphon ram is essentially like the common ram except that the waste valve is inclosed in such a way as to prevent the loss of the partial vacuum at the crest of a siphon. This ram could also be operated as an ordinary ram at the foot of an inclined supply pipe. The second air chamber *E* is needed to smooth off the flow.

At a distance of 25 ft. it is almost inaudible. That it is inexpensive to run is shown by Mr. Parmelee's statement that "25c. a year would cover the time and labor in cutting new washers for the valves"—the only repair he has had to make. It is remarkable that this machine is not on the market. It is eminently suited to raising small quantities of water from a shallow well where it is difficult or impossible to dig a trench for a pipe sloping to an ordinary hydraulic ram.

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Sioux City Concrete Pavements

SYNOPSIS—Sioux City, Iowa, has some 40 mi. of concrete paved streets and roads that have shown remarkable results in freedom from cracking and resistance to wear. These concrete pavements are laid in a different manner from that followed elsewhere. A member of the editorial staff of "Engineering News" visited Sioux City recently to examine these pavements, and the following article summarizes his observations.

Concrete pavements which have been in use five years and which show block after block without a single crack; concrete pavements which have been under traffic two or three years and on which the marks left in the original floating are still to be seen; concrete pavements which are costing practically nothing for maintenance; concrete pavements laid on grades of 12% to 16% which give satisfaction to teamsters; concrete pavements which have been a complete success from the beginning and are preferred by property owners to any other type—these are some of the things which are hardly believable by an engineer unless he actually visits Sioux City, Iowa, and sees them with his own eyes.

In addition, it may be remarked that some of the older concrete pavements in Sioux City are only 5 in. thick, and all are laid on crowned subgrades. Some streets have crowns as high as 14 in. The pavement laid in recent years, however, is 6 in. thick.

Success Not Due to Local Conditions

Engineers whose experience with concrete pavements has been less satisfactory are apt to say that the success of the Sioux City concrete pavements must be due to peculiarly favorable local conditions—subsoil, drainage or some more mysterious cause. As a matter of fact, a careful examination of all the pavements and of roads and streets where pavements are under construction leads inevitably to the conclusion that the conditions of soil, drainage, climate, traffic, etc., are quite as trying to concrete pavement as the conditions in any Northern or Eastern American city of 50,000 population.

The range of temperature in Sioux City is from 115° to —35° F. Sudden extreme variations of 50° are not unusual. Rainstorms with a precipitation of 1½ in. in an hour occur. Many streets are poorly provided with storm sewers. The subsoil in some instances is heavy, black and sticky. Some of the concrete roads that are now under construction run through lowlands and swamps. Therefore local topographic, climatic and soil conditions cannot account for Sioux City's remarkable success with concrete pavements.

Concrete on All Kinds of Streets

The 40-odd miles of concrete pavement in Sioux City includes streets of every character—downtown heavy-traffic streets, residence streets and country roads—and these pavements are on grades varying from level to 16%. With years of actual experience under all these conditions, City Engineer T. H. Johnson not unnaturally has come to look upon concrete as a universal paving material and stands ready and willing to pave any kind of street with it. Property owners almost unanimously petition for concrete when new paving is proposed. To the 40-odd miles of concrete paving already laid in Sioux City about 20 mi. more is to be added this year. Obviously, these things could not be if extraordinary success had not been attained with the use of concrete as a paving material.

About 15 mi. of the concrete-paved streets has street-car tracks. Concrete paving has proved so satisfactory that it has not only been adopted as standard by the city, but the street-railway company of its own accord has used concrete paving on several miles of repair work on pavements of other types. Figs. 3, 4 and 5 illustrate the details and appearance of some of these street-car track pavements.

Reasons for the Success

The prime factor in the success with concrete pavements at Sioux City is good workmanship. The second and hardly less important is good materials. Specifications help, but of themselves could never bring

FIG. 1. ROLLED SUBGRADE ON A SIOUX CITY "STREET," SHOWING COUNTRY-ROAD CONDITIONS

about either of these factors, for good workmanship and uniformly good materials are the products of eternal vigilance only. The Sioux City pavements are built under the constant personal supervision of a man who is heart and soul absorbed in this work. These are the real local conditions that influence results.

Thorough rolling of the subgrade is practiced even on steep grades. Only one instance could be found where the pavement slabs had moved or crept, and this one case was not serious, as only one corner of a slab had been raised. The specifications provide that the subgrade shall be rolled with a roller weighing not less than six tons, and the entire surface shall be passed over at least twice, with the usual provisions for filling holes and depressions and for wetting the subgrade before placing the concrete.

The cement must meet the requirements of the standard specifications of the American Society for Testing Materials. The sand used is an excellent quality of bank sand, testing 100% or better by the Ottawa standard. The coarse aggregate in most cases is Sioux Falls (S. D.) granite—a hard, reddish granite that makes first-class concrete material. Some pavements, however,

have been made of concrete in which a washed gravel was used, and these to all present appearances are hardly less satisfactory than the pavements built with granite aggregate. The proportions (used at present) are 1 part cement to 6½ parts of sand and coarse aggregate (leaner mixtures have been used). The usual mix is 1:2½:4, which is considerably leaner than that recommended by the leading authorities on concrete-road construction. The following clauses from the specifications govern the character of the aggregate:

The fine aggregate shall consist of bank sand or screenings from gravel, graded from fine to coarse, passing when dry a screen having four meshes per linear inch; shall preferably be of siliceous materials, clean, coarse, free from loam, vegetable or other deleterious matter; not more than 25% shall pass a screen having 50 meshes per linear inch, and not more than 3% shall pass a sieve having 100 meshes per lienar inch.

The coarse aggregate shall consist of crushed granite or quartzite, passing a 1½-in. screen and held on a ¼-in. screen, and containing no sandstone or soft, flat or elongated particles, and free from dirt, loam, vegetable and other deleterious matter.

Mixing and Placing the Concrete

Great care is given to mixing the concrete. Only a batch mixer of approved type may be used, and it must be equipped with a batch meter or some other automatic device for properly timing the mix. The mixing must continue for a full minute after all the materials are in the drum of the mixer, and the drum must be rotated at a speed of at least 12 r.p.m. The drum must be completely emptied before another batch is introduced. The mix, while not sloppy, is moderately wet.

The time of mixing concrete is an element in which nearly every contractor is tempted to economize. It is therefore necessary to see that a mixer of sufficient capacity is provided and that it is not overloaded. Experience in Sioux City up to the present year has been with one-bag batches; but one contractor is hastening progress by loading a 16-cu.ft. mixer with two-bag batches, which is within the rated capacity of the machine. The actual result, however, is a concrete no better mixed than a one-bag batch rotated ½ min. To prevent these conditions and insure a good mix, the specifications are to be revised to include a limit to the size of the batch to be mixed in machines of certain rated capacities. Thus a 15- or 16-cu.ft. mixer would not be used for greater than one-bag batches nor a 21- or 22-cu.ft. mixer for greater than two-bag batches, and so on.

Precaution is exercised in handling the wet concrete from mixer to pavement. Turnover carts for conveying the concrete are prohibited; bottom-dumping devices must be used. The reason is that if wet concrete is conveyed any distance the coarse aggregates settle to the bottom and when the load is dumped they are all on top, which defeats the great object aimed at—the *densest concrete obtainable.*

Rakes and hoes in spreading and leveling are not permitted. The spreading is done with shovels. Two

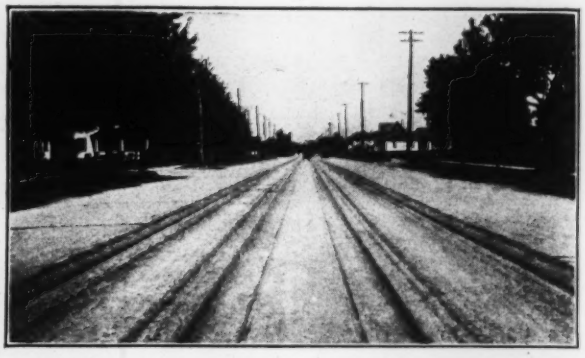


FIG. 4. STREET WITH TWO CAR TRACKS PAVED WITH CONCRETE

or more workmen, usually four, stand in and on the concrete, and they are continuously employed in going over and over the surface with long-handled oak-plank floats, 14x16 in. by 2 in. thick.

Adding Dry Material

It is at this point that there is introduced the chief feature in which Sioux City concrete paving practice as developed by Mr. Johnson differs from the practice of substantially all other engineers. As soon as the concrete is smoothed off by the floats to approximately the form of the finished roadway, there is spread over it a dry mixture of equal parts of cement and sand sufficient to absorb all surplus water. Every engineer knows how promptly concrete will stiffen when such a dry mix is added. The workmen can walk on it immediately, and

FIG. 2. JACKSON ST., SIOUX CITY, AN EXAMPLE OF GOOD CONCRETE PAVEMENT

FIG. 3. DETAIL OF PAVING AROUND CAR RAIL

FIG. 6. SPREADING MIXTURE OF DRY SAND AND CEMENT

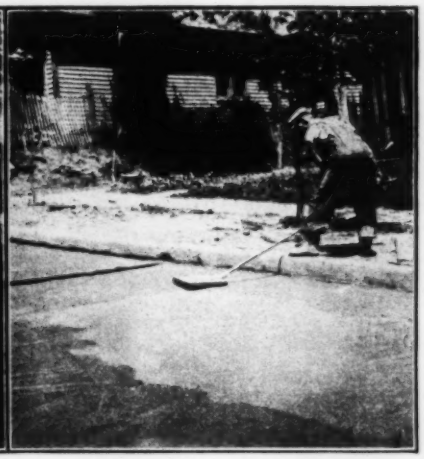


FIG. 7. FINAL FLOATING PROCESS

they continue working it with the heavy plank floats until all the surplus water is brought to the surface and absorbed by the dry mix.

This process was fully described by Mr. Johnson in a contribution to *Engineering News* of June 10, 1915, and also at the annual Conference on Concrete Roads, held in Chicago Feb. 15 to 18, 1916. The specification covering this part of the work is as follows:

> After the concrete is deposited and brought to a proper crown, it shall be immediately gone over at least twice with a float about 12x14 in. in size, made of 2-in. oak plank and carrying an 8-ft. gas-pipe handle. Immediately following this, a dry mixture—one part cement and one part sand—that has passed a No. 8 screen shall be evenly applied over the entire surface in sufficient quantity to absorb all water. After this the floating shall continue until the dry mixture is thoroughly incorporated with the mortar previously flushed to the surface. Subsequent floatings shall follow at intervals of 5 min. until the entire surface has been floated not less than five times after applying the dry mixture. At the last floating the mortar shall have reached a stage where it is pasty and adhesive and is slightly drawn along with the float.

Manner of Finishing Is Important

It is chiefly on this feature of finishing that other engineers differ with Mr. Johnson, and to this feature Mr. Johnson attributes a large share in the successful outcome of the work. Whatever other virtues the floating process and the addition of dry mortar may have, there is no question that they help materially to obtain a dense concrete. Much water is squeezed or sucked out, which flushes to the top and is absorbed by the dry mixture of sand and cement. This water would otherwise remain in the green concrete until evaporated or be drawn downward into a base not sufficiently wetted. It is generally accepted that when water leaves concrete as water, it carries along with it some cement. If allowed to be absorbed by the base, cement is carried downward where it is not needed. By forcing the water out through the surface, the cement is carried toward the top of slab where it is needed.

The floating or puddling of the wet concrete undoubtedly helps to prevent the formation of interior air bubbles, which cause a porous concrete, even when extremely minute. This floating is kept up until the surface begins to stick to the float, or in other words until the initial set has begun. The surface mixture then has almost the consistency of retempered mortar. The last floating leaves a scored, roughened surface, yet with all pores sealed, and the grains of fine aggregate coated with cement, rather than sharp and angular as when roughened with a broom, as is shown in Fig. 9. Chips of concrete broken from old pavements show a remarkably tough, fine-grained, flinty, dense concrete, the plane of cleavage being often smooth and more resembling an igneous than a sedimentary rock.

Noteworthy things in connection with the finishing and floating are these: No strikeboard, templet or other similar device is used to form the surface of the pavement. Once the concrete is properly distributed with shovels, it is not again disturbed. The crowning and all finishing are done by eye with the use of the floats.

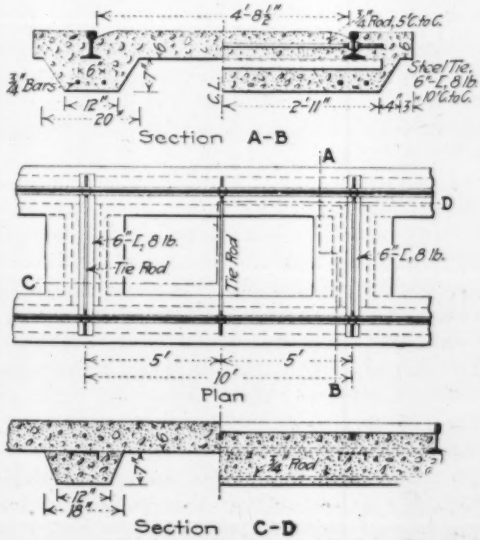


FIG. 5. DETAILS OF STREET-CAR TRACK CONSTRUCTION

It seems remarkable that a smooth, even surface and grade can be so obtained, but with a properly prepared subgrade and skillful workers it not only can be, but is regularly done in Sioux City practice. This simply means that the shovelers must have the necessary intelligence and skill to place the concrete properly at the start. Complicated crowns and valleys for drainage at street intersections are made in the same manner. Mr. Johnson in his discussion at the Second National Concrete Road Conference last February advocated this

method of finishing concrete pavement in the following words:

We are told that it takes about 4 cu.ft. of water to mix an ordinarily wet yard of concrete, only about one-half of which is used in hydrating the cement, the other half remaining in the concrete as free water. In other words, 7½% of the total volume is free water, and if left there to evaporate would result in voids equal to 7½% of the mass.

Our first floatings remove a portion of this free water and so close up the structure of the concrete that subsequent

FIG. 8. CONCRETE PAVING ON A 16% GRADE

evaporation is materially reduced. The dry mixture completes the removal of this free water, as is shown by the immediate stiffening of the concrete so that the balance of the finishing is done directly from its surface, without disturbing it a particle. This also furnishes enough mortar for properly finishing the surface. Being a rich mixture, it counteracts the effects of dust, dirt and other impurities brought to the surface by the water and effectually seals all the pores in the pavement, preventing evaporation and affording a hard, tough, dense, impervious skin coat for the surface of the pavement. This dry mix being half sand prevents the surface from crazing, as would be the case if neat cement were used.

The proper curing and protection of the pavement are not slighted. It is customary with a new pavement to require one man to be regularly employed throughout the day for a period of at least seven days in sprinkling the surface with a stream of water from near-by hydrants. When the temperature is below 50° F., the sprinkling is sometimes omitted, as of course it is in rainy weather. No traffic is allowed for 14 days.

Joints ½ in. wide are made transversely every 35 ft and longitudinally between the new pavement and the curbs or gutters on each side. They are formed by inserting during construction and leaving in place a joint filler consisting of strips ½ in. thick, which have a width 1 in. greater than the thickness of the pavement. The material composing these strips is ¼ in. of asphalt between two layers of the best grade of wool felt, thoroughly saturated, coated and bonded with a pure asphalt. (The now widely used Carey sandwich joint was originally devised to meet this specification.)

Concrete Paving and Concrete Girder Support for Car Tracks

The longitudinal joint between the paving alongside the street rail laid by the railway company and laid by the city consists of a single thickness of the best grade of saturated wool felt. In making transverse joints the concrete is deposited and tamped or spaded on both sides of the joint, floated with a standard "split" float and the edges of the concrete rounded with an approved "edger." The concrete for paving in the track area is mixed rather wet, 1 : 2½ : 4, and it is well puddled under the ties and rails. The form of construction is shown in detail in Fig. 5. The base and pavement proper are laid in one operation.

Longitudinal joints are placed between the paving done by the street-railway company (1 ft. on each side of the rail) and the remainder of the street pavement. No transverse joints are made, and a fine crack opens over each tie. The street cars that use these tracks are 20-ton 8-wheel cars with 21-ft. wheel base.

It will be noticed that here is a case where the concrete-girder construction for street-car tracks, which was extensively used a dozen years ago and generally abandoned, is now giving excellent satisfaction. Further, and still more important, here is a rail embedded directly in concrete, with no provision for elastic support, such as has so often been declared to be necessary, and both the concrete and the rail are standing up. Of course, the street-car traffic and the vehicle traffic of Sioux City, are nothing like as heavy as those of Chicago or New York; but there are thousands of miles of street-railway track subjected to no heavier service than that at Sioux City, and what will succeed there should succeed in a hundred other cities.

The street paving and track foundation cost about $2.75 per sq.yd., with rock at $2.25 per cu.yd.; sand, $1 per cu.yd.; cement, $1.40 per bbl.; common labor at $2.50, finishers at $5 and teams at $5 for a 9-hr. day.

Conclusions

Certain mooted points in Mr. Johnson's specifications have been looked on more or less as fads or hobbies. They are not. They are the products of continuous trial and experience. There is no detail in the method of construction outlined that has not sprung from some previously unsatisfactory experience or which has not been proved essential for a desired result.

Again, in attaining the results that make Sioux City pavements truly remarkable no small amount of credit is

FIG. 9. APPEARANCE OF COMPLETED SURFACE OF A PAVEMENT IN USE FOR SEVERAL DAYS

due to the contractors with whom Mr. Johnson has worked. They have shown a willingness to coöperate and to follow as well as to make suggestions. Having established a reputation for their work, it is natural for them to wish to maintain it.

In conclusion it must not be inferred that the object of this article is to make out that Sioux City pavements

are perfect or that they contain no cracks or other imperfections whatsoever. It was impossible in a two days' visit to obtain by personal inspection an exact knowledge as to what percentage of the pavement slabs have cracked. Last fall, however, Mr. Johnson made such an inspection of between five and six miles of pavements in a typical district, pavements two to five years old, and he found about 1% of the slabs showing cracks, which would seem a fair index of the condition of the whole yardage. The widths of the pavements varied from 30 to 40 ft. and the lengths of the slabs from 25 to 35 ft., 25 ft. being the distance between expansion joints in the earlier pavements. It is also true that there are three- and four-year old pavements one-half and even a mile long which show absolutely no cracks throughout their entire lengths.

The only concrete pavement in Sioux City that shows signs of serious deterioration is one over which materials were hauled in building a new pavement. Motor trucks carrying 15 to 20 tons were driven over this stretch of pavement at high rates of speed, and the effects of this battering are plainly evident in the many cracks. The pavement was only 5 in. thick.

There remain unanswered queries that are sure to be raised. Are concrete pavements satisfactory to traffic on 16% grades? Apparently Sioux City concrete pavements are. Tests and demonstrations have been made on the street shown in Fig. 8, which horses have no difficulty in climbing with heavily loaded wagons. The pavement is never really slippery even when wet. The character of the surface when new is shown in Fig. 9. This roughness apparently lasts several years, and the concrete itself is of gritty, granite-like texture.

Is it possible to make satisfactory repairs in concrete pavements after openings have been made for sewers, water pipe, etc.? In Sioux City it is done. There is no denying that these concrete pavements are difficult to break into. Openings have to be chipped away with drills and sledges. Breaking up the slabs with crowbars is not possible. Repairs over backfills are made in the same manner as the original pavement, care being taken to clean and wet the edges of the pavement so as to obtain as good a bond as possible. Some of these repairs are hardly noticeable.

What has been the maintenance cost of Sioux City's concrete pavements? Practically nothing. Except on the street referred to above, where the pavement was ruined by motor trucks, most of the cracks which have shown up are too minute to require filling with tar. A small amount of tar patching has been done, but the cost is insignificant when distributed over the 1,000,000 sq.yd. of concrete pavement in the city.

How much more than ordinary concrete pavements do these Sioux Citly pavements cost? Approximately 10c. per sq.yd., and all this goes into labor or *workmanship*. As already stated, the mix is leaner than current practice, no reinforcement is used, and armored joints have never been considered essential. In other cities with inexperienced contractors the cost of the better workmanship might be more.

It is unfortunate that physical tests have not yet been made to demonstrate the difference between Sioux City paving concrete and other concrete. For instance, tests for abrasion, porosity and specific gravity might prove that just as much difference exists between a block of concrete made by the methods described and a block in ordinary concrete-paving practice as exists between hard-burned No. 1 paving brick and an underburned No. 3 brick. To make such tests would require that the blocks be sawed out of typical paving slabs, with such care as not to destroy any of the original bond between the particles within the test piece. Few city engineering departments are equipped to obtain such test pieces, and Sioux City is not one of them.

New Methods of Handling Coal and Ore

Recent developments in coal- and ore-handling apparatus were discussed in a brief talk by C. D. Gilpin at a meeting of the Association of Iron and Steel Electrical Engineers, in Pittsburgh. He described a new style of coaling dock recently installed in a Southern port. The purpose of the design is to obtain the flexibility of the bin system without the high initial cost of the latter. Part of Mr. Gilpin's description follows:

> The dock carries a runway next to the water edge and not very much above water level; on this runway travels a loading tower. Behind this is another runway, elevated above the first by means of a trestle and carrying on its rails a turnover car dumper of the movable type. Beyond the car-dumper runway is a return track for empty cars. The loaded cars are pushed onto the dumper by means of a locomotive, and the coal is dumped into a 100-ton hopper on the rear of the loading tower, the dumper having been brought into line with the latter. The tower hopper is provided with a gate, through which the coal is fed into a scraper conveyor. The latter carries the coal up a pivoted inclined boom which extends out over the boat when loading and carries a telescopic chute at its outer end so that the coal may be directed where desired. The conveyor on the boom is the largest ever built of this type, having a capacity of 3,000 tons per hr. when the boom is approximately level.

Another loading tower will be added to this equipment as soon as business warrants it, so that one tower may be kept busy loading into empty hatches while the other takes an occasional carload from the dumper for trimming hatches already partly filled. Such a system as this may be operated by one 300-kw. rotary converter, and the peak loads are not sufficient to cause any noticeable variation at the end of a 6,600-volt line 4 or 5 mi. long.

At the Chuquicamata plant of the Chile Exploration Co. two gantry cranes are used to handle copper ore in and out of six concrete tanks 150x100 ft. by 16 ft. deep. The tanks are filled with ore by means of a gantry crane carrying a 36-in. belt conveyor. After a tank has been filled with ore, sulphuric acid is turned into it and the copper leached out. The residue is then excavated by another gantry, the trolley of which is almost identical with that used on stiff-leg unloaders along the Great Lakes. The operator is located directly over the bucket of the gantry and can therefore work very close to the sides and the bottom of the tank without injuring the sheet-lead lining. A simple mechanical distance limit is used to prevent over-travel when lowering the bucket. The tailings are dumped into a chute that projects over the tank, while the refuse is discharged into cars.

The Coal Production of the United States in 1915 as announced by the U. S. Geological Survey was 442,600,000 tons of bituminous coal and 89,000,000 tons of Pennsylvania anthracite. The three leading states in soft coal production were Pennsylvania, with 158,000,000 tons, West Virginia with 77,000,000 tons, and Illinois with 59,000,000 tons. The other states in which more than 10,000,000 tons were mined, are in the order of their production: Ohio, Kentucky, Indiana and Alabama.

Field and Office

Seagoing Barge-Emptying Dredge for China

By F. C. Coleman*

The accompanying views show an interesting type of dredge that has recently been developed by A. F. Smulders, of Schiedam, near Rotterdam, for the Hai-Ho Conservancy Board, Tientsin, China. This dredge is of the barge-emptying and suction-loading type, and is capable of discharging the spoil into barges alongside, or through a floating pipe line 1,000 ft. in length, or through a shore delivery pipe line over a distance of 9,800 ft. and when dredging at anchor, with a different suction mouth, can reach to a depth of 25 ft. The normal service speed is approximately 8 knots.

The hull is of Siemens-Martin steel and was built in accordance with Bureau Veritas rules and under special survey. The hull is divided into seven water-tight compartments. There are two compound double-crank engines, with surface condensers, for propulsion, each developing 250 hp. at normal speed. One of these is arranged to be uncoupled from the propeller shaft and coupled to a 22-in. pump when the dredger works as a pumping station. One compound double-crank engine,

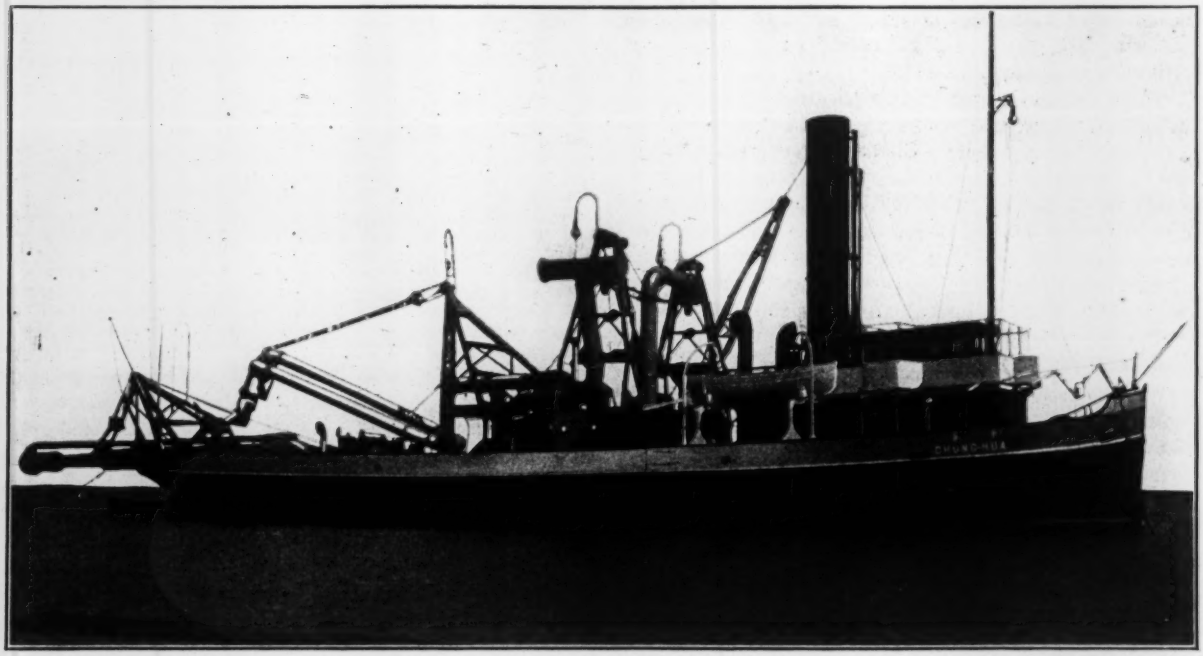


FIG. 1. SEAGOING BARGE-EMPTYING DREDGE "CHUNG-HUA" FOR HAI-HO CONSERVANCY BOARD

The length between perpendiculars is 124 ft. 8 in.; the breadth is 32 ft. 10 in., and the depth 10 ft. 8 in.

The vessel is used as a suction dredge, either working at side anchors or in motion, and as a stationary pumping station for the discharge ashore of spoil out of barges. For pumping while in motion, the dredge is arranged to discharge over either side into barges towed alongside or through an opening in the bow, at which a floating pipe line is connected when dredging at side anchors. For balancing the vessel the shore-delivery pipe line is fitted on the port side, while the barge suction is usually swung over the starboard side. The suction pipe for direct dredging at anchor is provided with a suction mouth, armed with a sleeve, so fitted as to avoid clogging when dredging a furrow 8 ft. deep in easily collapsible earth. When the dredge is in motion, the suction pipe is capable of reaching to a depth of 20 ft.

with surface condenser, developing 500 hp. at normal speed, is placed in the middle of the vessel for driving two sand pumps. The exhaust steam of the auxiliary engines is discharged in the condenser of the sand-pump engine. The stern sand pump draws from the 24-in. suction pipe for direct dredging or from the 20-in. suction pipe for barge emptying. A stone-catching box is placed between the sand pump and the suction pipes; the mixture is delivered overboard into barges on either side or through the floating pipe line. An elbow is fitted instead of a pipe if the mixture has to go to the second sand pump as when both are working in compound for shore delivery. One compound double-crank high-speed engine drives directly a three-stage centrifugal pump for delivering water at the suction mouth at a pressure of 100 ft. water column.

The two main boilers are of marine type and have a heating surface of 1,500 sq.ft. each; the working pressure is 120 lb. A donkey boiler also works at a pressure

*Central Station Hotel, Newcastle-on-Tyne, England.

FIG. 2. DREDGE "TIENTSIN" OF TIENTSIN, CHINA

of 129 lb. On deck are the suction-pipe hoisting gear, the maneuvering winches, anchor davits, etc. An engine and 100-volt generator supplies current for six arc lamps of 3 amp. each, and the necessary 16-c.p. incandescent lamps in crew space, cabins, engine and boiler compartments. Search-light apparatus is provided to be occasionally used instead of some of the arc lamps. On deck, in front of the funnel, there is arranged the wheelhouse, which is at the same time the chart room. In it are placed steam and hand steering gear for working the rudders, a compass and a twin- and two single-reply telegraphs. The dredge has cabin accommodation for the officers, and crew space. The cabins are steam heated.

When working as a pumping station and discharging spoil over a distance of 9,800 ft. through a 24⅜-in. pipe line, the dredge delivers by means of the sand pumps 35 cu.m. of water per minute; the water-pump output is 36 cu.m. of water per minute. When dredging at anchor and discharging through 1,000 ft. of 20-in. floating pipe, using one sand pump, the duty is 35 cu.m. per minute; while dredging in motion and delivering into barges alongside the output for the sand pump is 70 cu.m. of water per minute.

This dredge is the ninth vessel that the Smulders company has supplied to the Hai-Ho Conservancy Board. It would appear at first sight that in China manual labor for dredging work would be much cheaper than mechanical power; but, despite the fact that Chinese labor charges are five times lower than in Europe, mechanical appliances have proved to be much below the cost of manual labor. This difference is brought about not only by reason of the high power developed in a dredging plant, but also, by reason of the fact that coal is 50% cheaper in China than in Europe; and the weather does not affect the general expense with dredging machinery so much as with human labor.

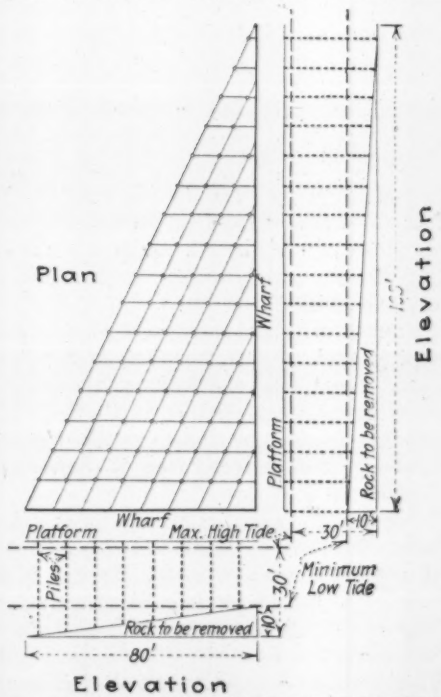
Subaqueous Rock Excavated from Platform

By Charles C. Phelps*

A submerged ledge of rock recently had to be removed at the drydock of the Grand Trunk Ry., Prince Rupert, B. C. Although the water is calm at this place, the rise and fall of the tide averages 20 ft. The shallowness of the water over the rock to be excavated and the large tidal variations rendered impractical the usual methods of subaqueous excavation by means of drill boats or adjustable drilling platforms (as described by the writer in *Engineering News*, Nov. 18 and 25, and Dec. 2, 1915). Instead, a temporary platform was erected over the entire work at the same level as the main dock, as shown in the accompanying sketch. There was sufficient mud overlying the rock to assist in holding the piles in place.

A drill with 9-in. stroke and 6½-in. bore (Ingersoll-Rand, K 64) was used. It was mounted in a heavy cast-iron saddle which was substituted for the usual weight on an ordinary pile-driving outfit. A 20-hp. oil-fired boiler supplied the steam to operate the drill. The ways were greased and the improvised drilling rig was slid around on the platform wherever it was desired to put down a hole.

The rock was a very hard schist weighing 168 lb. per cu.ft. The holes were 3 in. in diameter spaced on 5-ft. centers. Sixty per cent. powder was employed, made up in special sticks 15 in. long and 2 in. in diameter.



SKETCH OF PLATFORM USED IN ROCK EXCAVATION AT PRINCE RUPERT

The ground was broken by this so that it could easily be handled with an orange-peel bucket.

The drilling was started on Feb. 7, 1916, and finished on Apr. 13. Drilling was carried on six days per week, 20 hr. per day. In addition, the men worked on one Sunday, but were idle for five days, making a total of

*Ingersoll-Rand Co., 11 Broadway, New York City.

54 days in operation. The average progress on an average day ranged between 5 and 6 ft. per hr., which covered the effect of delays and dead time. The average speed per hour while actually drilling was about 8 ft. The greatest progress attained in a day of 20 hr. was 120 ft. The poorest footage record was 9 ft. in 20 hr. The total footage drilled during this period was 4,269 ft. with a loss of 299 ft., leaving a net result of 3,970 ft. of holes. A total of 335 holes were shot and 72 holes were abandoned.

This contract was taken by James R. Stirrat; M. J. Hobin, of Prince Rupert, was the superintendent.

Digging End of Power Shovels

The digging equipment, the "business end," of a power shovel comprises the swinging circle, boom, dipper sticks and dipper, the swinging and crowding engines (which are practically always duplicate), the hoisting engine and the rigging. There is a great similarity among the engines used by the several shovel manufacturers. They are practically always of the double-cylinder, horizontal reversing type. In most cases, the boiler is purchased from a boiler manufacturer, and in probably all but one instance is designed for a working pressure of 125 lb.

The design of shovel booms varies in the case of the different manufacturers, but the two general types are the two-piece white-oak boom—armored inside and outside with steel plates, with the clearance space from the center of the boom to the base filled with white oak—and the all-steel boom. Believers in the armored boom claim that it can withstand stresses which would throw an all-steel boom permanently out of true. They claim further that the rivets in an all-steel boom are bound to work loose—an inconvenient condition when in the field. Makers of steel booms, while admitting that there have been cases where rivets have worked loose in the field, retort that the working loose of the bolts which clamp the armor plates around the oak booms is not less annoying. The Marion, Erie, Bucyrus and Osgood shovels can be equipped with either type.

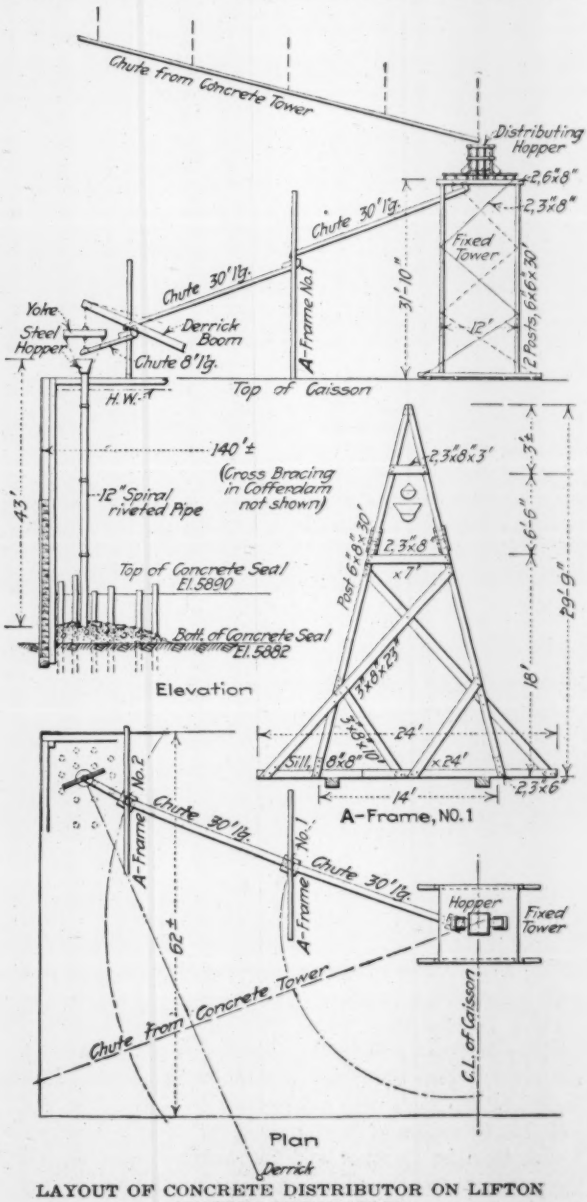
Large steam shovels, i.e., the 6- to 8-yd. machines used for stripping coal usually have all-steel booms well trussed and braced. In one instance the boom is pin connected to step castings resting on the two inner sills of the rotating frame immediately over the roller path, and is stayed by rods running from the truck frame to the middle of the boom.

The boom and dipper handle built by the American Steel Dredge Co. for their single-line shovel is of unusually neat and compact construction. Instead of employing bolts and rivets, the boom is built up of two channels welded together, flange to flange. This makes a smooth-surface box section.

The Thew idea in booms is that an all-steel heavy channel construction is the best. The Thew shovel is distinctive on account of its two independent crowding devices, both operated from the same hoisting engine. When the contractor wants to do road grading, he removes the long dipper stick and uses the short dipper arm. When he wishes to dig a trench he uses the shipper-shaft crowd, and chains the short dipper to the boom structure after removing the dipper. The trussed-boom structure consists of steel shapes and plates placed vertically, horizontally and diagonally, resulting in two booms in one.

Concrete in Dry Open Caisson Deposited by Tremie

The substructure of the Lifton pumping station at the Bear Lake river-storage development, Utah, was built by sinking by inside excavation an open timber caisson, about 62x140 ft. in plan, a depth of 45 ft., driving piles in the bottom and filling the caisson with concrete, first depositing a seal layer 8 ft. deep in the bottom. The seal was placed in the design in the expectation of heavy water pressure, but the excavation proved drier than expected, so that the seal virtually is a pile cap. The concrete above the seal elevation is full of openings for pump inlets, etc., which require a great amount of formwork inside the caisson proper. The caisson furthermore was thoroughly cross-braced, so that altogether there was a great deal of timber work which would interfere with the deposition of the concrete inside the caisson. On this account and further to remove the possibility of poor concrete due to



LAYOUT OF CONCRETE DISTRIBUTOR ON LIFTON STATION FOUNDATION

too long a drop, a tremie system of concrete deposition was installed. Contrary to usual tremie practice there was no water through which the concrete had to fall.

The accompanying drawing shows the details of the tremie layout. It consisted primarily of a central fixed tower resting on the top cross-bracing of the caisson, with a distributing hopper which took the concrete from the chute leading from the main concreting tower and distributed it through secondary chutes to the tremie. The secondary chutes rested on intermediate A-frames which were moved around the top cross-bracing of the caisson as different parts were concreted. From the A-frame farthest from the center tower a short chute led to the tremie, which was hung by means of an I-beam yoke from the boom of a derrick, the mast of which was outside of the caisson area. The smaller A-frame was removed as the concreting approached the center of the caisson area.

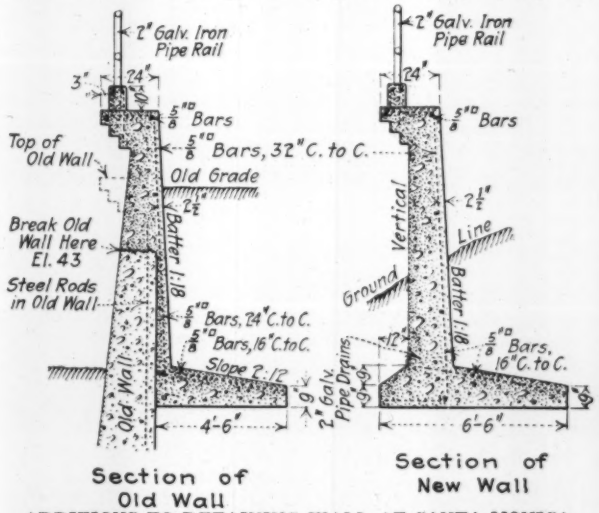
The tremie proper consisted of a 12-in. spiral riveted pipe with a funnel top dependent from the yoke. The operation was conducted in the same manner as the usual tremie work in water is carried on; that is, the bottom of the tremie pipe was kept buried in the concrete and raised slowly, so that the concrete ran out only at the rate at which it was fed.

This work was carried out by the Jarrett-Chambers Co., Inc., 30 West 42d St., New York City.

Building New Retaining Wall on Top of Old One

By C. E. Hasse*

In the course of recent improvements on Colorado Ave. in Santa Monica, Calif., the problem of increasing the height of an old retaining wall was solved in an unusual manner. The street grade along the south property line



ADDITIONS TO RETAINING WALL AT SANTA MONICA, CALIF.

was raised an average of 4 ft. The original fill was made some twelve years before and was well compacted. The old concrete wall was anchored to concrete blocks under the street fill, and the foundation extended a considerable depth below the original ground surface.

After a careful study of these conditions and the peculiar design of the old wall, it was decided to consider the old wall as a strip of solid rock foundation to carry the toe of a reinforced-concrete wall of cantilever type. Enough of the top of the old wall was broken off to expose about 18 in. of the vertical rods for tying together the old and the new work. The railing and the coping were made to conform in appearance with the old work that did not come within the scope of the reconstruction. The joint of the battered face of the old wall with the vertical face of the new wall was covered by a mask giving the effect of a pilaster.

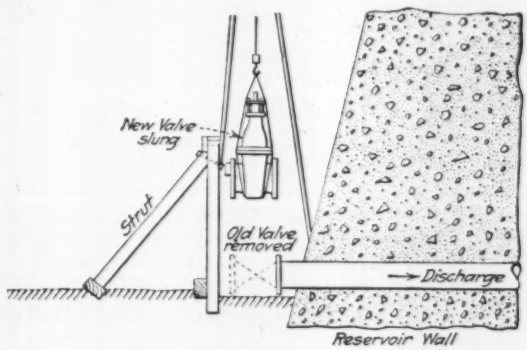
In the drawing the section at the left shows a typical cross-section of the new wall built upon the old. At the right is a cross-section of the new wall, which extended 80 ft. beyond the old wall. The complete removal of the old wall and the construction of a new one to the full height would have more than doubled the cost of the construction.

The design was worked out and the plans were drawn by the writer under John A. Morton, City Engineer.

*City Engineer's office, Santa Monica, Calif.

Replacing a Reservoir Scour Valve Against Pressure

A scour-valve spindle was found stuck, at the Katoomba storage reservoir in New South Wales. The occasion for attempting to operate it came when it was decided to increase the height of the dam. It was necessary to maintain the water near the old level during this work, since the water could not be wasted nor could



HOW A NEW SCOUR VALVE WAS PLACED AGAINST PRESSURE AT THE KATOOMBA STORAGE RESERVOIR

it be allowed to rise against the green concrete as the dam was built higher. Another spindle was obtained and inserted through the nut. This time, when the key was applied, the spindle was turned a few threads when the cast-iron lug holding the nut snapped and the whole valve became unworkable. This accident was not due to any unusual stress, but merely to the cementing of the valve faces against the guides owing to long disuse. In the recent report for 1915 of the department of public works, F. C. Kendall of the Water-Supply and Sewerage Branch explains the measures taken to replace the valve.

A new valve (both old and new were 12-in. stop valves) was at once obtained having a flanged connection bored to suit the flanged end of the scour pipe. Over the site of the valve a shear-leg tackle was erected and the new casting was hung directly over its intended permanent position, as shown in the sketch. Before taking off the old valve, a vertical timber frame was erected at a distance from the scour-pipe flange about 2 in. in excess

of the length of the valve casting. The frame consisted of two 6x6-in. uprights bottomed and fixed securely against a sill piece, and tied at the top by the heavy cross-piece and braced by diagonal struts on the downstream side as shown.

The bolts in the flange of the old valve were unscrewed and drawn back flush with the scour-pipe flange, all ready to insert in the new valve. A gang quickly pulled away the old valve, and the water began rushing out through the pipe under 26-ft. head.

The new valve was lowered through the water by tackle. It was directed against the framework so that in descending it was guided by the uprights. When the flanges of valve and pipe were opposite each other, the pressure was almost entirely relieved and the new valve was bolted to the pipe flange with little difficulty.

Concreting with Dump Car and Inclined Tower

A new idea in the placing of concrete is shown in the accompanying view. This represents the work on the foundation for an office building at the coke works of the Youngstown Sheet and Tube Co., Youngstown, Ohio, which is being built by the Stone & Webster Co.

Instead of a vertical tower with elevator bucket to the head of the distributing spout there is a steel incline on which a car is operated by a cable hoist. The car receives the batch from the mixer and dumps it automatically into the hopper-head spout at the end of the incline. At the right the concrete material is being dumped into the charging hopper of a Jaeger vertical-drum concrete mixer of 10 cu.ft. capacity. At the side of the drum is the gasoline engine which operates the mixer and the hoisting cables for both the charging hopper and the 10-ft. concrete car. One man controls all movements of charging, mixing and dumping.

The incline is 50 ft. long, and is built of 4-in. channels in 10-ft. lengths, supported by adjustable legs or bents of steel angles. The car is of the same capacity as the mixer and is dumped automatically at the head of the incline. The spouts are in 12-ft. lengths, mounted on pivots, so that they can be swung to any desired position and thus cover a considerable area.

This method of handling concrete is considered of special advantage for work which is not large enough to warrant a high elevator tower and long spouting system. It eliminates the labor cost of wheeling, as well as the difficulties of handling carts or wheelbarrows in restricted space. Steady and rapid progress can be made, as one batch is being mixed while the car is making its trip with the previous batch, so that the car is in almost continual operation.

The mixer, engine, hoist, water tank and charging hopper, together with the gallows frame for the hopper cables, are all mounted on a steel-frame truck, making a complete and portable unit. The entire outfit, including incline, can be erected in about 1½ hr. and dismantled in about ¾ hr. This concrete distributing system was devised by the Jaeger Machine Co., of Columbus, Ohio, which builds the outfits complete.

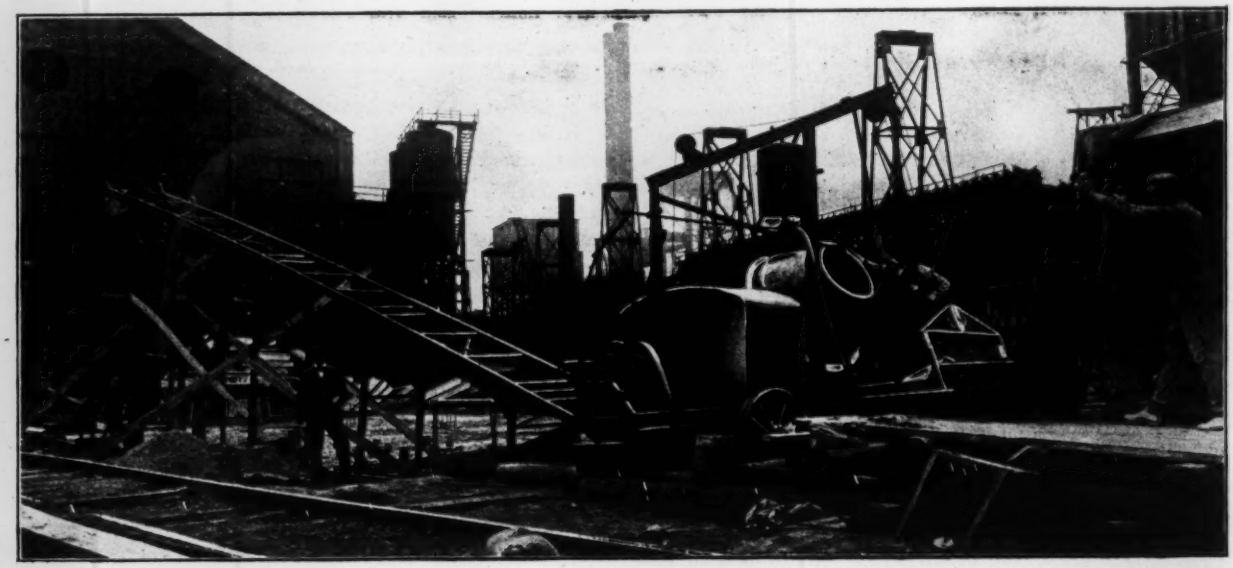
Two Recent Specifications for Hand-Mixed Concrete

Where reinforced-concrete pipe for culverts is made by company forces, the amount made at one time may be too small to warrant the use of a mixer. Two railways which make their own culvert pipe specify quite different methods of mixing the concrete by hand: one mixing the cement, sand and stone before adding water, while the other adds water before the coarse aggregate.

On the Great Northern Ry. the concrete mixture is 1:1½:4, using either gravel which will pass a 1-in. screen, or crushed stone that will pass a 1-in. and be held by a ¼-in. screen. For hand-mixing the specification makes the following requirements:

> The stone (or gravel) and sand shall be spread on a water-tight platform to a depth of 6 in.; on this the cement shall be evenly spread and the mass turned till of a uniform color. Water shall then be added sufficient to make a plastic mass, and the whole turned over and over until thoroughly mixed.

On the Michigan Central R.R. the concrete mixture is 1:2:4, using stone or gravel that will pass a 1-in. and



CONCRETING PLANT WITH DUMP-CAR INCLINE FROM MIXER TO SPOUTS

be held on a ¼-in. screen. For hand-mixing the specification is as follows:

The sand shall be spread on a water-tight platform. The cement shall then be evenly spread over the sand and the mass spaded until thoroughly mixed. The dry mixture shall then be raked to the sides to form a hollow, into which the necessary amount of water shall be poured, and the mass shall then be spaded until the mortar is thoroughly mixed to a uniform consistency and color. The mortar shall then be spread out to a thickness of about 6 in. and the stone be deposited in the same. The whole mass shall then be turned, shoveling it toward the center in a heap and then raked out again. This process shall be repeated not less than six times or until all the stone is fully covered.

Street Work Done Under Tent

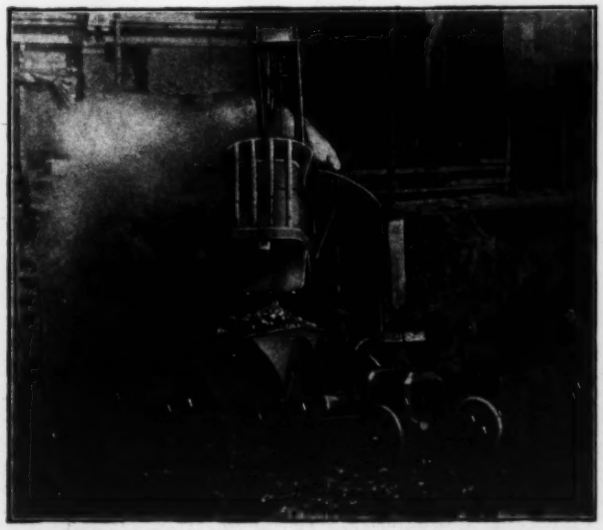
In spite of severe rains, an urgent piece of storm-drain repair under a street in Charlotte, N. C., was recently completed by City Engineer S. H. Lea, after a tent had been pitched over the excavation.

During a record-breaking storm (1.5 in. of rainfall in a half hour) a low-lying section of the city was flooded, and after the water had subsided a sink hole, about 4x6 ft., was found over an old drain. A force was set to work to excavate down to the drain, which was about 14 ft. below ground. Rain continued to fall, and the sides of the pit caved at frequent intervals—although they were well braced.

To protect the concrete work and to allow the men to proceed without interruption, a 10x12-ft. tent was erected over the pit. The drain, a 24-in. terra-cotta sewer pipe, was found to be in bad condition. It was 20 years old and had crumpled in places; at the main break it had collapsed at the bottom from the load of earth above it.

Converted Automobile Used as Motor Dump-Wagon

A light motor dump-wagon adapted for use on small jobs is shown in the accompanying view. It was built by the Smith Form-a-Truck Co., of Chicago, for a contractor at Detroit, Mich. The truck is made from a Ford automobile. The rear axle is removed and the Smith extension frame attached in its place, the engine being connected to a countershaft carrying the sprockets for driving chains to the rear wheels. On this frame is mounted a 1½-yd. Lee dumping body. The machine is rated at 1 ton capacity, with allowance for 50% overload. Nearly 90% of the load is carried by the rear axle.



MOTOR TRUCK OF 1-TON CAPACITY, MADE FROM A FORD AUTOMOBILE

NOTES

Backfilling Machine Pulls Sheetpiling—In the construction of the Como-Snelling sewer system, St. Paul, Minn., described in "Engineering News," June 8, 1916, the contractor had occasion to remove a large quantity of wood sheetpiling driven in the lower half of a trench 25 to 30 ft. deep. For doing this he utilized an Oshkosh backfilling machine. The hauling line was passed down to a sheave under the truck of the machine and thence over another through a snatch-block to a three-part tackle hung from a beam on the Carson trenching-machine framework and taking hold of the sheetpile by a jaw. The hoisting tackle could be readily moved the full span of this beam without moving the backfiller. The contractors, the Thornton Brothers Co., St. Paul, stated that the device had saved much time and money.

PULLING SHEETPILING WITH BACKFILLING MACHINE

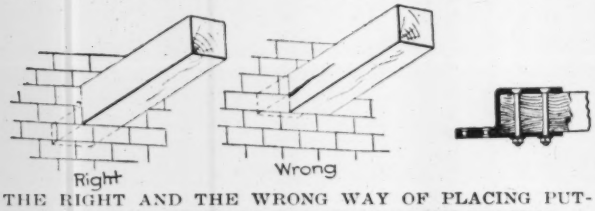
A New Steel Car for the Bureau of Fisheries, especially designed for carrying live fish long distances, has just been put into service. Insulated tanks on each side of the car contain 130 ten-gallon cans in which the fish are carried. The water in the cans is aërated by air pumps driven by steam from a 6-hp. boiler. Tanks for a reserve water supply are located beneath the car. An icebox of one-ton capacity enables the transportation of species which require the water to be kept cool. The car also contains living accommodations for the crew of five men that travel with it. The total weight of the car and equipment is 150,000 lb., and it is designed for a load of 35,000 lb. The car is 60 ft. long and is carried on two six-wheel trucks.

The Cost of Operating a Ford Motor Car for three years, during which time it ran 14,225 mi., is given in the following summary, from the records of the Grand Valley project of the United States Reclamation Service. The car is a 1912 model 20-hp. 4-cylinder 5-passenger Ford. It was the only motor car owned by this project up to the first of this year. The following is an itemized cost record:

Classification	Year 1915 Unit Cost	Year 1915 Amount	3 Yr. to End of 1915 Unit Cost	3 Yr. to End of 1915 Amount
Gasoline	$0.0165	$60.31	$0.0121	$172.04
Lubricants	0.0035	19.81	0.0025	35.70
Tires (including repairs)	0.0145	82.89	0.0163	231.85
Other repairs	0.0535	306.22	0.0475	676.01
Supplies	0.0010	5.95	0.0007	9.26
	$0.0830	$475.18	$0.0791	$1,124.86
Other incidentals:				
Garage expense	0.0061	35.00	0.0076	107.90
Towing	0.0016	9.00	0.0007	10.00
Chauffeur	.....	.....	0.0009	12.65
Depreciation	0.0408	233.39	0.0310	443.82
Totals	$0.1315	$752.57	$0.1193	$1,699.23

The number of miles run in 1915 was 5,721, and the average number of miles per gallon of gasoline was 17. The total number of miles run per gallon of lubricant was 231.

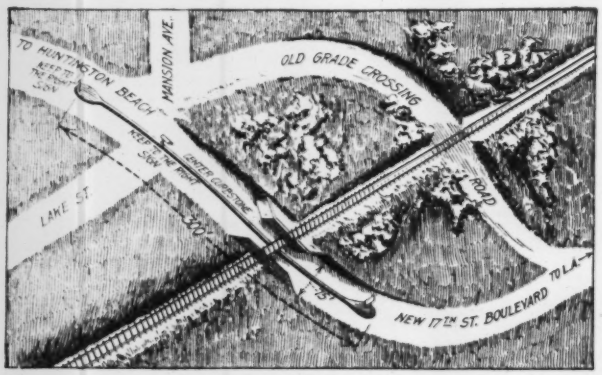
Putlogs, Putlocks, Puds and Crossbars are synonymous, being the several names given by masons and builders to horizontal sticks that jut out from a wall and afford direct support to the planking of a temporary platform. They are discussed in a new book, "Scaffolds." The best putlog material is chestnut, spruce being a good substitute. Split or hewn material is preferable, but the chief requisite is the soundness of the material. Putlogs should be at least 4x4s when used in the ordinary bricklayers' scaffold, and should project over the ledgers at least 1 ft. They should be placed as shown in the left-hand sketch, and at least three should be provided under every plank of the platform. Brick walls are



THE RIGHT AND THE WRONG WAY OF PLACING PUTLOGS, AND A PUTLOG FOR WIDE BRICK SPACING

frequently laid up with wide intervals between the rows of brick, a space of ⅝ in. being more or less common. This has led to the devising of forms of putlogs that enable the builder to erect a scaffold without leaving out bricks here and there for the support of the platform. One of these special designs is shown at the right in the sketch. Instead of being notched at the end the putlog is fitted with a shoe consisting of two pieces of sheet steel each about ¼ in. thick, one piece lying straight along the bottom, the other being bent at right angles twice. Three strips are folded together as shown and their free ends joined by countersunk rivets. The tongue is narrow enough to allow being placed between two successive rows of bricks.

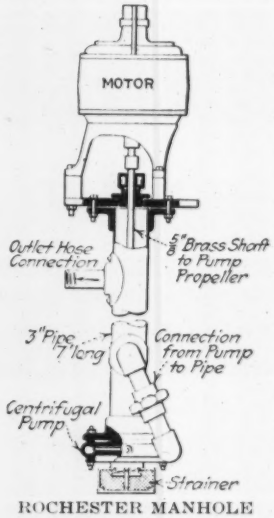
No Grade Crossings need be encountered in entering Huntington Beach, Calif. The sketch shows the worst grade crossing eliminated. Two bad features obtained here formerly: The right-of-way of the Southern Pacific tracks was



HOW DANGEROUS CROSSING WAS ELIMINATED AND THE SHARP CURVE STRAIGHTENED

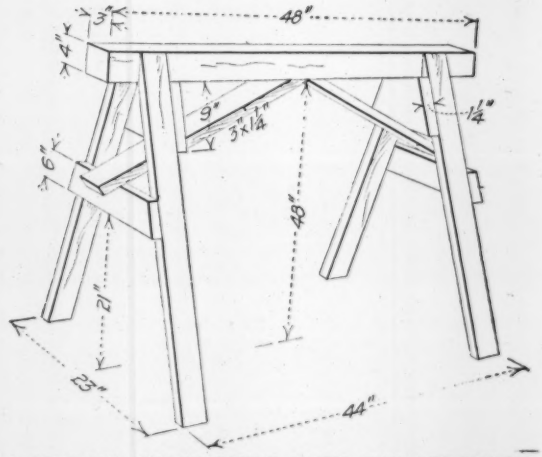
obscured by trees and a cut, and the highway crossed the track with a reverse curve. The road has been straightened to some extent, as shown. The railway crosses the road on a 50-ft. span. This is unfortunate, as the boulevard is elsewhere 75 ft. wide. A center curb of concrete 6 in. high runs along the road for 150 ft. on each side of the crossing. At the ends of the curb large electric signs warn vehicles to "Keep to the Right."

A Manhole Pump, home-made and motor driven, as built by the Rochester (N. Y.) Gas and Electric Co., is shown in the accompanying sketch. Construction and use are thus described in the company's employees' magazine: A ¼-hp. 1,400-r.p.m. vertical motor and a small centrifugal pump were connected by a 3-in. spiral-riveted pipe 7 ft. long. The pipe acts as a support for the motor, is long enough so that the pump can be lowered into the water without submerging the motor and at the same time conducts the water from the pump to the street level. The shaft of the motor and the impeller of the pump are connected by a ⅝-in. brass rod running through the 3-in. pipe. The complete apparatus weighs about 170 lb. and is supported by a small crane attached to one of the company's trucks. The crane is a small pipe with a long-radius bend and hook at one end, so that the pump can be swung over the edge of the truck and lowered into the manhole by means of a block and tackle. The pump requires only a small amount of power, and the motor is operated by the battery that operates the truck. In the spring of the year and after heavy rains the manholes that have no drains are flooded with water above the cables. The cable ducts connecting the manholes allow the water to flow from manhole to manhole until a number have become filled, making it necessary to pump the water out before any work can be done on the cables. In the past a hand pump was used. This motor-driven pump will empty a manhole in 15 min., whereas it would take two men almost an hour to do the same work with a hand pump.



ROCHESTER MANHOLE PUMP

A Well-Designed Horse of the mason variety is shown in the sketch. This structure—it is sufficiently important in the building trade to be thus dignified—is often used as a support for planking, thus forming a scaffold. Sometimes this temporary construction reaches six or eight tiers in height. Such scaffolding is unstable at best and not infrequently is a



A MASON'S HORSE BUILT BOTH FOR STRENGTH AND CHEAPNESS

criminal menace reflecting upon the building superintendent or his superiors. There are various arrangements of timbers all answering to the name of horse, but the design presented herewith and recommended by the Travelers Insurance Co., of Hartford, Conn., is about as cheap and as simple as one could ask.

Editorials

Prospects for Railway Building in Russia

The recent remarkable military successes of Russia and the placing of a $50,000,000 Russian loan in the United States make opportune the announcement by the American-Russian Chamber of Commerce[1] of New York City that great opportunities for American capital and American engineering talent will be open in Russia after the close of the war. The organization referred to includes a number of the leading bankers and business men of New York, Boston and other cities.

More than any other European country, Russia is rich in undeveloped natural resources. The prompt exploitation of these resources will be essential for Russia in order to meet the enormous war debt that it has incurred. It is noteworthy, however, that this debt has been largely subscribed by its own people, a thing that has only been made possible by the great economic advance that Russia has made since the close of the Russo-Japanese war.

In order to develop its vast natural resources in mineral wealth, agriculture and lumber, a large amount of railway construction is the first essential. During the war, as is well known, Russia is building a large mileage of military railways made necessary by military conditions. This will be followed at the close of the war by commercial railway lines, leading Russian economists estimating that at least 10,000 km. per annum must be built. The United States, notwithstanding the sparsely settled portions of its area west of the 100th meridian, has 1.9 mi. of railway to each 100 sq.mi. of area. Russia has only ½ mi. of railway to each 100 sq.mi. of area. The United States, again, has 29 mi. of railway for every 10,000 of population. Russia has only 3.2 mi. of railway. In order to build these railways Russia must import at least half of the steel rails and rolling stock that will be required.

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Repetitious Road Discussions

One who attends many road congresses—and there is one being held somewhere every week—or reads the voluminous proceedings of these meetings, must be struck with the monotonous sameness of practically all the papers presented. Almost invariably they deal with elementary principles, and then launch out into the author's theories and recommendations—which are likely to be common knowledge. An engineer who has not had recent experience in roadbuilding, and who is suddenly called upon to assume responsibility for selecting a type of pavement to meet conditions which are reasonably ascertainable, finds mighty little to help him in such discussions.

It may be argued that the inexperienced engineer should have recourse to some paving expert for advice. But who are the highway experts but the identical authors of these voluminous proceedings? And in reading their papers and discussions, our seeker-after-information speedily finds out that these experts seldom clearly present any deciding factors in pavement design.

What the seeker-after-information wants is not repetitions of elementary matter which may be found in any standard textbook, but frank and honest expressions of experience with this or that type of pavement. Was it a success, or was it not a success? If it failed, how, why and under what conditions; if successful, why and against what odds? From a symposium of succinctly stated frank expressions of experience, something definite could be concluded.

There are many reasons why such experiences are but rarely given. Engineers are reluctant to get up before their fellows and acknowledge errors, mistakes, and failures; they dislike to pass judgment on this or that material, for politic or other reasons; and there is the proverbial tendency of man to believe he has cornered all knowledge on some subject to which he has given particular attention, and to wish to keep it cornered.

If the proceedings of road congresses are to be of practical value to engineers, if they are to do something more than to boom good roads, those who take part in them must "get down to brass tacks," be frank with one another, and tell what they do not know as well as what they do. Attention will then be concentrated on the real problems of modern roadbuilding, which are many as well as real.

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Applications of Powdered Coal Fuel Steadily Increasing

A quarter of a century ago numerous inventors worked on the problem of using powdered coal as fuel and some of them achieved a fair degree of success. The advent of cheap fuel oil about that time, however, prevented the invention from being successful commercially except in the field of cement burning. Here the use of powdered fuel was a very important factor in the success of the rotary kiln. It effected a large reduction in the cost of burning compared with the fuel oil which was used at first. The use of powdered fuel for other purposes was abandoned until three or four years ago, when it was successfully applied to metallurgical furnaces. Since then the use of powdered coal has been experimented with in various other directions, notably as a locomotive fuel.

Those responsible for the use of powdered coal in the cement industry early learned, through some very costly and fatal accidents, that certain precautions were necessary in its use to guard against disastrous explosions.

[1] The American-Russian Chamber of Commerce has offices at 60 Broadway, New York City. Charles H. Boynton is its President, and among its directors are Samuel McRoberts, Vice-President of the National City Bank; Charles H. Sabin, President of the Guaranty Trust Co.; Charles Hayden, of Hayden, Stone & Co.; William J. Chalmers, of Chicago; and William Butterworth, President of Deere & Co., of Moline, Ill.

When it is recalled how frequently bituminous coal in place in the mine gives off inflammable gas, it can readily be understood that when bituminous coal is ground to an impalpable powder it is much more likely to give off a gas, which mixed with air in any confined space only needs a chance spark to produce a heavy explosion. Fine coal dust itself when floating in the air is also well understood to be a dangerous explosive. Further than this, any considerable bulk of powdered coal held in storage for a few days is apt to develop spontaneous combustion.

At the recent Master Mechanics Convention, Mr. Chambers, who has been in charge of experiments with powdered fuel on a locomotive on the Chicago & Northern Ry. declared that it was not safe to store a quantity of powdered coal exceeding 10 to 15 tons longer than three or four days at a time.

Anyone familiar with the chemical constitution of coal will readily understand that its liability to spontaneous combustion when powdered will vary greatly with different coals. If a consignment of coal happened to have an especially large percentage of pyrites in it, someone might be disagreeably surprised at the rapidity with which it would develop heat after being ground.

The question was raised in the discussion as to what a railway would do should it adopt powdered fuel for general use on its locomotives. At large railway coaling stations it is common to deliver to locomotives 2,000 tons or more of coal in 24 hr. The answer to this question is that in handling powdered coal the thing to do is to avoid storage as much as possible. Coal-pulverizing machinery should be of sufficient capacity to handle the coal as fast as it is used, with a sufficient margin for extraordinary demands and for breakdowns. A minimum storage and no dust are the standing rules that must be observed to obtain safety in the use of powdered coal.

Many have predicted the commercial failure of powdered coal burning systems on the ground that present methods of using coal are so efficient that any increased saving in fuel through pulverizing will be more than offset by the cost. The advantages from the use of powdered coal, however, come from other sources than a mere increase of efficiency in burning the fuel. Those who are promoting its use in locomotives, for example, hope to make the powdered coal burning locomotives so free from smoke and sparks that they can be used inside city limits for switching locomotives to offset the public demand that the railways shall expend enormous sums for electrification, in order to get rid of locomotive smoke. Locomotives burning powdered coal could also be used in forested regions where the railways are now in some cases compelled by public authorities to burn oil fuel to avoid the risk of setting fire from scattered sparks.

Probably the greatest field for the burning of powdered fuel, however, will be in aiding the economical utilization of fuels which are difficult to burn efficiently by ordinary methods. For example, there are in the far West deposits of lignite of almost unbelievable magnitude. The United States Geological Survey has just issued a bulletin reporting surveys of the quantity of lignite in Perkins and Harding Counties in the northwest corner of South Dakota. The Geological Survey estimates that in these two counties alone there is more than one billion tons of lignite available for mining, and this estimate was made without including any beds less than 2 ft. 6 in. thick. The Dakota lignites contain nearly 50% of volatile matter and have shown remarkably good results as a fuel for gas producers and as a material for briquettes. The cheapest way to use this fuel, however, is in the form of powdered coal. The high content of volatile matter is especially favorable to firing in this way.

Another fuel which seems capable of use in powdered form is peat. Sweden, which has no coal deposits, possesses large peat bogs. A recent report of the Department of Commerce states that the Swedish state railways have been experimenting with powdered peat as fuel for locomotives, and the railway directors have recommended an appropriation of $350,000 for a factory to produce sufficient powdered peat to supply all the locomotives on one of the state railway lines.

Using the Tremie for Placing Concrete in the Dry

The tremie has become an indispensable tool in underwater concreting because it is thoroughly recognized that concrete freely dropping through water easily separates into its components, thus destroying its purpose and value. That a similar though less pronounced action takes place when air instead of water is the medium is sometimes admitted but as a rule the drop has to be very great before any precautions against segregation are thought worth while. One case where this uncommon admission is tacitly made is noted on another page of this issue, where the use of a tremie in depositing concrete in the dry coffer-dam at the Bear Lake pumping station is described.

The practice there used is worth copying in many pieces of concrete work. Too often concrete is laboriously conveyed over a considerable distance with every care to prevent segregation only to be dropped to its final position in a free fall that tends, at least, to nullify all of the other precautions. The tremie is designed to cure just such an evil, to preserve, at some loss of speed, the integrity of the mass. In heavy work, where entrance to the opening to be filled is uncongested, chutes and buckets can readily be brought close to the place of deposition, but in thin walls or columns, not too cluttered up with interfering rods, or in large mass work where forms and braces prevent entrance, it would seem that the additional aggregation of the concrete gained by tremie placing would weigh heavily against the undoubted added expense and trouble of such an innovation.

Elementary Acoustics for Outdoor Speaking

Why is it that when a great educational institution celebrates some important event and invites distinguished men to deliver addresses, no attention whatever is given to producing acoustic conditions that will enable the audience to hear? A notable instance occurred at the recent dedication ceremonies at the Massachusetts Institute of Technology.

The dedication of the new buildings was the crowning event of Technology's celebration week. No pains and expense were spared to make the affair a success. In order that the great central court might be ready for the dedication ceremonies, a large force of workmen labored all

night long, removing the grand stand, which on the evening previous had accommodated 7,000 spectators of the pageant. The speakers' platform was placed in front of the central portico, and in front of it were ranged thousands of chairs for the alumni and the invited guests.

The eminent men who addressed the audience were experienced public speakers, familiar with all the arts that assist in making the spoken word audible to an audience; yet to probably two-thirds of those present the speakers might as well have been the actors in a moving-picture scene, for all that could be heard.

It needs only the most elementary knowledge of acoustics to understand why the speakers' voices were ineffective. Back of the platform on which they stood was the double row of huge columns which extends along the main entrance to the building. The voices of the speakers, reflected from the curved surfaces of these columns, were broken into a confused mass of echoes.

Conditions almost exactly similar occurred at another famous educational institution a year ago, when President Frank J. Goodnow was installed at Johns Hopkins University. Here also, an audience numbering several thousand was gathered in front of the main building of the university; the speakers stood on the portico of this building, and behind them was the series of columns which forms the chief architectural decoration of the entrance. To make the acoustic conditions even more difficult, the audience was separated from the speakers by a broad terrace, a flight of steps and a driveway some 20 ft. in width. The inevitable result was that three-quarters of those who came to hear the distinguished men saw their gestures, but had not the faintest idea what the speakers said.

Still another case is worthy of record here. In a certain large Eastern city a few months ago, the local engineers' club invited all the engineering and scientific organizations of the city to join in a "get-together" dinner. The dinner was held in the roof garden of one of the principal hotels, an area decorated with pergolas and with part of it roofed over and a part open to the sky above. The speakers' table was placed directly under one of these open spaces, with the result that the after-dinner speeches floated harmlessly up to the blue vault of heaven and were inaudible to those seated 25 or 30 ft. away.

Now, it will surely not be disputed that if it is worth while for a distinguished man to go to the trouble of preparing an address and making a journey to address an audience and worth while for the audience to take the trouble of going to hear him, then it is certainly worth while to surround the speaker with whatever reasonable accessories will enable his voice to be heard.

Anyone familiar with the laws of sound set forth in any elementary treatise on physics can easily understand why the speakers' voices at the Technology celebration and at the other places mentioned reached only a small part of the audience; and with the same elementary knowledge it is easy to understand why simple accessories, which have been used for centuries, are an effectual aid to a speaker addressing an audience out of doors.

One can see in cathedrals built in the Middle Ages reflecting sounding boards, often of great architectural beauty in their design, placed over the pulpit in such a manner as to reflect the speaker's voice toward the audience and prevent it from being dissipated in the upper part of the edifice. Devices of a similar order, although of the crudest construction, have been used for generations on the speakers' stands at country camp meetings. The care with which Billy Sunday designs the pulpits in the tabernacles which he builds so as to make what is said on the platform audible all through the edifice has been widely published by the newspapers. In Germany one sees the same principles carried out with scientific thoroughness in the band stands erected in some of the municipal parks. Here the roof that shields the stand from the weather is carried down to close it entirely on one side, and on the other it is entirely open. The smooth interior of this inclosing structure is of such a form as to reflect the sound outward over the garden where the audience is seated.

Many other instances could be cited to show the great advantage it would have been to the speakers and to the audience at Cambridge and at Baltimore if some simple sound-reflecting structure had been provided over the speakers' stand.

That it is possible to produce acoustic conditions that will enable an audience out of doors to hear a speaker as perfectly as indoors is admirably illustrated by the Greek Theater at the University of California. Of course, all the conditions there are not reproducible in an auditorium for temporary use; but well-arranged sound-reflecting surfaces around the speaker will accomplish a great deal.

The most puzzling problem in connection with the whole matter is the principle involved. Why did these two great scientific institutions, justly eminent for their achievements in original research, fail to apply the elementary principles of science in the conduct of a great celebration? Still another instance of a similar sort is the auditorium built by the University of Illinois a few years ago, which has become famous because of its phenomenally bad acoustic properties.

It is altogether probable that the men responsible in each of the cases discussed had at least an elementary knowledge of the science of physics. The failure lay in not applying this knowledge in a practical way. It is a question worth serious consideration whether the situation of which the foregoing cases are typical does not show a defect in our modern educational systems. It is not the knowledge which a man possesses in an abstract way that enables him to do his part in the world's work, but the knowledge of which he is able to make practical application. In the competition to lead in original research, has the fact been lost sight of that the business of the school laboratory is first of all to enable the student to become practically familiar with elementary principles of science?

There is now pending in Congress a bill to grant a Federal appropriation of $15,000 a year to each state to aid original research in mechanical science carried on at some educational institution. That such an appropriation might produce some measure of benefit will not be denied; but is original research at scattered schools and colleges after all the great need of technical education? Is there not vastly greater need at the present day of a better application of existing knowledge and often of elementary knowledge? In other words, are not the mistakes and blunders and inefficiencies in all departments of life, in both public and private business, due to ignorance of and failure to apply the well-known principles of science, rather than to a lack of the facts which original research might reveal?

Letters to the Editor

Pump Tests with Pitot Tube

Sir—The writer has read with great interest the article in *Engineering News*, July 6, 1916, entitled "Difficult Pump Test Made with Pitot Tube." The most startling part of the paper is the author's statement that "the possibility of using a Pitot tube was affected by the common assumption that this instrument cannot be used except where the water is under pressure."

It would be of interest to know where this "common assumption" originated and the reason for it. If Mr. Grunsky knows of any laws of mechanics or hydraulics that prevent the use of a tube under negative pressures or that detract from the accuracy of the results when so used he ought to give the information to his brother engineers.

During the last twenty years the writer has conducted tests of about two hundred pumping plants and in a majority of cases has used the Pitot tube to measure the quantity of water. In scores of cases the tube has been used in the suction pipe because the velocities in the suction pipes are usually less turbulent than in the discharge pipe. Often when the tube has been used in the discharge pipe it has been under a vacuum, for in this section the discharge pipes are made to discharge under water in drainage plants.

Given good instruments and careful work, the writer has never been able to discover any difference in the accuracy of the Pitot tube whether under pressure or vacuum. Primarily it depends on the difference of head at static and impact openings and it is difficult to imagine any fundamental difficulty whether the static head is positive or negative.

Another interesting point is Mr. Grunsky's elaborate manometer for reading the difference of head on the Pitot tube. The results obtained, as shown by the sample curves, were uniform and satisfactory. It seems to the writer, however, that it would have been much simpler and easier had a water column been used (instead of tetrachloride of carbon) in a plain inverted U-tube the two legs coming straight up from the top of the tube.

The velocity of 10 ft. per sec. does not seem excessive as it is an easy matter to measure velocities that are much greater by means of a mercury column in a U-tube. The writer has measured velocities as great as 26 ft. per sec. in this way. If the head on the Pitot tube had been read directly in feet of water, as suggested above, when the velocity was 10 ft. per sec. the difference of head would have been 1.55 ft. Heads of 3 ft. or more are often read in the way suggested. The advantage of the inverted U-tube manometer with water as the fluid is that there is no correction to be made for the specific gravity of the liquid and that air bubbles rise to the top revealing leaks and thus make it possible to be absolutely sure that the condition of the tube is satisfactory before observations are begun.

In regard to measuring the head on the pump—the method used seems to be correct provided the true average pressure in the suction pipe may be observed at *I* (Fig. 2, p. 9, July 6, 1916) and the true average pressure in the discharge pipe is at *K*. The correctness of this assumption can only be proved in a given case by experiment. Other openings in the same cross-section need to be made and observations taken. It is supposed, of course, that observed head read from manometer was corrected for difference of velocity head in suction and discharge pipe in case such a difference existed.

W. B. Gregory.

Tulane University, New Orleans, July 18, 1916.

Government Engineering Not Offered in Competition

Sir—Several letters appearing in your columns, and your recent editorial, relative to "free government engineering services,"[1] have been noted with much interest; and inasmuch as there has been direct reference made to the Lexington, Ky., sewage treatment case, with which I am entirely familiar, I believe a few statements regarding it will be of interest to your readers.

Preliminary plans and recommendations for a method of sewage treatment for Lexington were prepared by the writer's firm, under a contract entered into with the city officials. Bonds were voted for the installation of sanitary improvements and at the same time a new set of City Commissioners was elected. To these latter was submitted the plan proposed by my firm, and certain suggestions and recommendations by promoters who claimed that they could by an improved method of treatment of the city's sewage save Lexington thousands of dollars. Obviously there arose in the minds of the new Commissioners a question as to which of the proposed methods would be the best for the municipality.

The United States Public Health Service, a nonpartisan, nonpolitical department of the Government, having in its employ officials of broad experience, wide reputation and sterling integrity was appealed to. This department sent two of its most competent and experienced representatives to advise with the city. Doctor Frost, Passed Assistant Surgeon, who is in charge of the Government sanitation and drainage investigation work at Cincinnati, advised the Lexington authorities that it was "not the province of the Government engineers to make surveys and detail reports, looking to the preparation of the working plans and specifications, as those things belonged to the duties of the consulting engineer engaged by the local authorities."

The foregoing statement is of record, and can be verified. These specialists investigated the different plans and processes recommended and suggested. Their report analyzed the accumulated data and in conclusion advised the city as to the method that was best adapted to local requirements, and specifically recommended that the city re-

[1] "Engineering News," June 1, 1916, pp. 1052, 1056; July 6, 1916, p. 36.

tain a consulting engineer to render the necessary detail engineering service.

Having come in direct contact with the methods of this department and realizing that the United States Public Health Service is not only rendering the cities and states invaluable service but is also endeavoring to coöperate with the engineering profession, it gives me much pleasure to indorse the work they perform and to suggest a closer affiliation between engineers and this branch of the Government service. P. H. Norcross.

Atlanta, Ga., July 11, 1916.

Most Philadelphia Sewers New

Sir—In *Engineering News*, of July 6, p. 17, is an article entitled "Regular Inspection of Sewers Part of Maintenance."

In the beginning of the article you state, "As in all the older Eastern cities, the sewers of Philadelphia are wearing out."

I cannot let this statement pass without calling attention to the fact that 20% of the main and branch sewers have been built since 1904, 50% since 1894 and 80% since 1884, so that three-fourths of the present mileage is of modern design and construction and is calculated to stand from one to 300 years. Therefore, I think your statement is not justifiable.

George E. Datesman,
Director, Department of Public Works.

Philadelphia, Penn., July 14, 1916.

[The editor admits that the general statement, so far as it concerns Philadelphia, does not apply. Apparently most of the old sewers of Philadelphia have already worn out and have been replaced by a second generation of sewers.—Editor.]

Brakes for Hydraulic Turbines

Sir—The matter of providing brakes for hydraulic turbines equipped with pivoted or Fink gates seems to have received little attention. Several instances have occurred recently where such turbines not equipped with brakes could not be stopped by closing the gates. At least one firm of turbine builders is strongly of the opinion that a brake should be provided as a regular equipment on every turbine of this type. However, they find that engineers seldom specify that such brakes be included except in special cases where the head is relatively high.

The pivoted gates of a hydraulic turbine commonly serve two functions: (1) To regulate the quantity of water supplied to the turbine as the load varies; (2) to shut off the flow through the turbines when the turbine unit is shut down.

The Fink pivoted type of gate is admirably adapted to the first of these uses. It is by no means as well adapted for the purpose of shutting out the flow through the turbine. In some cases it appears probable that the design might be approved and the efficiency increased if the gates are so constructed as to serve the first purpose only, and separate means are used to shut off the flow through the turbine. For large turbines under relatively high heads it is practically impossible to make the points of the vanes swing against the sides of the adjacent vanes with a sufficiently accurate fit in all cases to prevent some water spurting or leaking through into the runner of the wheel. As a rule, some of the vanes will be much tighter than others. Furthermore, if an obstruction, however slight, is lodged between two of the vanes, near their points, it will prevent a tight closing of the turbine gates. With a modern hydraulic turbine of efficiency 90% or over, with roller bearings, a surprisingly small jet of water is sufficient to keep the turbine in motion when it is once started, especially when it operates under relatively high heads.

In view of these conditions and to facilitate stopping of the turbines to remove obstructions from the gates, it seems desirable that brakes should be provided, and I am writing this letter to call the attention of engineers to the matter with the hope of obtaining their opinions in relation thereto. Robert E. Horton.

57 No. Pine Ave., Albany, N. Y., July 20, 1916.

"Inventories and Histories"

Sir—At the time that the editorial under the above heading (*Engineering News*, June 29, 1916, p. 1243) was being written, the writer was standing on an eminence in Wylandville, Washington County, Penn., gazing on what might be called a "graveyard of railways."

The editorial says: "There are many miles of abandoned railway roadbed, or the site of former roadbed, along the present track of our more prosperous railways."

At the village mentioned can be seen the partly completed immense cuts and fills of the famous old Hempfield railroad which was under construction in 1857 between Wheeling (then in Virginia) and Greensburg, Penn., leaving the City of Pittsburgh to the north. This partly finished railway, now utterly forgotten, was a cross-country line and for its utter disregard of the obstacles of topography and its directness of alignment, rivaled the famous line between Petrograd and Moscow.

The unfinished cuts and fills and other works stand as mute examples of the temerity of former civil engineers, and to paraphrase the editor: "The future student of railway-location economics could learn much from an inspection of this line, from which to deduce sound principles of location or relocation."

In 1878 the writer, when locating the Pittsburgh Southern R.R., utilized some portions of the abandoned roadbed. Later on the Baltimore & Ohio R.R. absorbed the Pittsburgh Southern for its Pittsburgh-Chicago line, and later still in revising the line between Wylandville and Clokeyville took up the track which had been laid on the old Hempfield grade, and which now is grown up with trees and undergrowth, and used the grade as a right-of-way for telegraph and telephone lines. A few years ago another railway line was partially built through the village, the Chartiers Southern R.R., owned jointly by the Pennsylvania, Vanderbilt and Baltimore & Ohio interests. Much of the grading and masonry was done but no track was laid.

The writer knows no place in the United States where "The rise and fall of railroads" is illustrated to better advantage. Leading out of Wylandville the old roadbed of the Pittsburgh Southern is now occupied for a distance of several miles by one of the principal Washington County highways. Emile Low.

Buffalo, N. Y., July 9, 1916.

Don J. Whittemore's Services to Engineering

By E. E. R. Tratman*

Don J. Whittemore's life work was in the development of the Chicago, Milwaukee & St. Paul Ry.—its development from a small local line into one of the greatest railway systems of the West, aggregating over 10,000 mi. in length and extending from the Great Lakes to the Pacific Coast. His connection with this work may be said to have begun in 1860, when he became Chief Assistant Engineer of the La Crosse & Milwaukee R.R. The western division of the road (Kilbourn to La Crosse) was sold at foreclosure in 1863 and its purchasers organized the Milwaukee & St. Paul R.R., which also acquired control of the whole line. Mr. Whittemore was made Chief Engineer of the company, which had then 275 mi. of line.

The Milwaukee-St. Paul line was completed a few years later, and the Chicago-Milwaukee line in 1872, to give adequate connections with the East and South. In 1874 the company changed its name to the Chicago, Milwaukee & St. Paul Ry., and at that time it had built and acquired a total of about 1,400 mi. of line. It reached Omaha in 1882 and Kansas City in 1887. The annual mileage of new construction for several years ranged from 50 to 500 mi., and the total mileage increased to 5,657 mi. in 1890 and 7,511 mi. in 1912.

The company was one of the most active in the development of the central Northwest, building and acquiring lines to form a network of main and local lines, so that its chief engineer had extensive and varied duties and responsibilities, to say nothing of difficulties. All of the many notable features were constructed under Mr. Whittemore's supervision, and these included many large bridges, particularly those over the Mississippi and Missouri Rivers.

About 1905, the company decided to build an extension from the Missouri River to the Pacific Coast. Separate companies were organized in each state, but in 1908 these were all combined under the name of the Chicago, Milwaukee & Puget Sound Ry. This was opened in 1909, and in 1913 the line (2,081 mi.) was absorbed into the Chicago, Milwaukee & St. Paul Ry. system. Mr. Whittemore remained as Chief Engineer until his resignation in December, 1910, at which time he was made Consulting Engineer of the company in recognition of his long and distinguished career in its service.

The preparation of an adequate or detailed biography of Mr. Whittemore is rendered difficult from the fact that he outlived his contemporaries. It may be said that since he began his engineering career, in 1847, two generations of engineers have passed away. Such men as Shaler Smith, Charles Paine, Willard S. Pope and others could have testified to his qualifications and would have delighted in paying tribute to his talents. The present source of information is in the younger engineers who were associated with him during his later years, but they could not enjoy the intimacy and consequent knowledge of him as a man that belonged to his friends who were more nearly equal to him in age. In fact he was numbered among the fathers of the profession when men now elderly were among the youths looking up to him for counsel and help. It is to be noted that it is 44 years since he became a member of the American Society of Civil Engineers, and 32 years since he was President of the Society.

The foregoing relates to the professional career of Mr. Whittemore as a factor in the development and growth of the country, but this biography would be incomplete without appreciative reference to the human or personal side of his nature. He was a man of strong character, self-reliant, confident and able to cope with difficulties. Such elements as these were necessary in the early days of pioneer railroading, and were no less useful during the years that he was chief engineer of a strong railway system. But with his strength of character he combined a quietness and reserve of manner which led him to retirement rather than to activity outside of his regular work.

He was devoted to his profession and his friends, and loyalty was one of the marked elements of his character. His advice, which was always sound and to the point, was given to younger men more for their own general good and future development than for the immediate results to be shown in their work. He had an unusual faculty of giving advice in short pithy terms, and in such a way that the hearer would remember and practice it. Undoubtedly all of the numerous members of his staff during his long career must have benefited through this kind of advice, perhaps without realizing the extent of his influence.

He was always a student. He was fond of mathematics, and on an inspection trip it was common for him to propose some sort of a puzzle composed of figures. He was naturally inclined to be an investigator, and was greatly interested in discovering some cheap process for the manufacture of aluminum at a time when it was a very expensive metal to produce. In the same way he took great interest in the manufacture in this country of portland cement, and with both of these materials he contributed by experimental work to an extent that would have been recognized had not the development in manufacturing these products been so rapid as to throw into the shade the early experimentation. Being somewhat reserved in temperament, he conducted his investigations privately, and said little as to his own work and accomplishments. Mr. Whittemore was one of the first to see and develop the possibilities of the cement rock found near Milwaukee, Wis. He was prominent in the establishment of the Milwaukee Cement Co., which flourished for several years and furnished the cement for many large structures. In railway work, one of his striking ideas was that of using flat-topped rails and flat-tired cylindrical wheels, in place of the round-top rail and coned wheel. This he advocated in a paper before the American Society of Civil Engineers in 1889.

He was a great reader as well as a thinker, and it has seemed to many of his intimate friends that but for his characteristic reticence and reserve he might have done more than he did for the promulgation of engineering knowledge. His experience and his retentive memory qualified him to have made contributions to engineering literature which would be extremely valuable to the profession. It is to be regretted also that he did not write more in the way of experiences and reminiscences, for he could have written in a way that would have been profitable and would have encouraged the younger men in their professional work. This is a point of view which might well be given consideration by engineers of long experience. Although reserved, and in recent years living a retired life, he was a genial companion.

*Resident Editor of "Engineering News" at Chicago.

Phenomenal Rains the Cause of Southern Floods

SYNOPSIS—Weather Bureau records of heavy July rainstorms and views of destroyed bridges in southeastern United States.

Rains of extraordinary intensity as well as extraordinary duration in the southeastern section of the United States occurred throughout the first three weeks of July and culminated in the third week in downpours of unprecedented extent. As a result practically every river was in flood and the consequent damage very great. Had the territory been as thickly settled as that in Ohio, the flood losses of 1913 in that locality would have been duplicated. As it is, the slowly accumulating reports show loss of property of about $12,000,000 and of 80 lives. Meteorological data of approximate accuracy have been collected by the United States Weather Bureau and some reliable statements are avaliable as to structural damage. These together with some photographs of destroyed bridges are presented herewith.

A tropical storm moved inland over extreme western Florida and southern Alabama on the night of July 6-7. It continued to move very slowly northward and passed beyond the confines of the state on the 10th. Meanwhile large amounts of moisture were precipitated over the state and in the regions to the eastward. By the morning of the 11th rain over Alabama had practically ceased, but it continued intermittently over the neighboring state of Georgia, eastern Tennessee, western North Carolina and South Carolina, during the 12th and 13th. By the morning of the 14th a fresh disturbance from the Atlantic passed inland over South Carolina, and gave torrential rains over the watersheds of the Atlantic drainage, especially in the Carolinas on the 14th, 15th and 16th. The great loss of life and destruction of property in the south, especially in the Carolinas, was due to the second disturbance, which as above stated, was separate and distinct from the Gulf storm of July 6-10.

Although this second storm could not be charted after July 17, rains have continued in the South, especially in the Carolinas. The continued heavy precipitation over this area is well shown in the accompanying table of Weather Bureau stations and by the map in Fig. 1, which gives rainfall contours for the two weeks ending July 18. In addition to the distributed rainfall noted in these summaries, on July 15 the 24-hr. records for some mountain stations in South Carolina were as follows: Effingham, 13.24 in.; Cheraw, 9.38 in.; Kingstree, 12.60 in. Complete accounts of the rainfall and river stages cannot be compiled until the mailed reports are all received at Washington.

These rains caused the most destructive floods in the Catawba, Broad and Yadkin Rivers in the mountains of

FIG. 1. RAINFALL CONTOURS IN SOUTHEASTERN STATES, JULY 5-18, 1915

North Carolina and the Santee River, below Columbia, S. C. The worst destruction was along the Catawba River, all bridges on that stream being destroyed. The tributary mountain streams became raging torrents; valleys of creeks and rivers from Marion to Rutherfordton, Blacksburg and Gastonia are scenes of ruin and devastation.

The floods on the Catawba and connecting streams reached a crest height that exceeded all previous records by several feet. Exact figures are difficult to obtain at this early date and it is impossible to state comparative elevations in all cases. The oldest inhabitants, however, cannot recall anything comparable in the flood line and history must be called upon to tell of former inundations. It is recorded that a flood occurred early in 1701 that raised the Santee River to a height of 36 ft. above normal. A similar flood is described as occurring on the Broad and Catawba Rivers in January, 1796.

River heights are still hard to get. At Granite Falls, N. C., the Catawba River was from 10 to 12 ft. higher

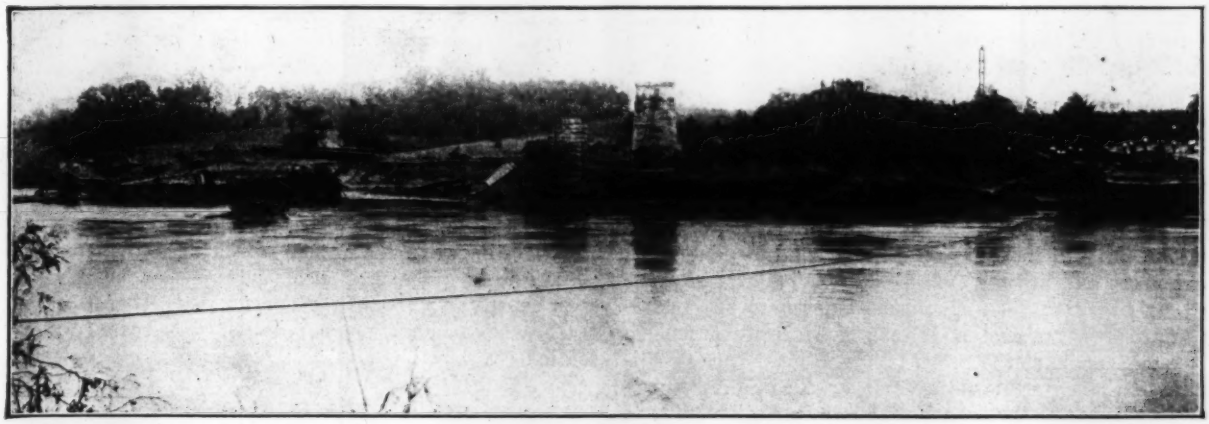
TABLE SHOWING DAILY PRECIPITATION IN INCHES FOR JULY 6-24, 1916

(United States Weather Bureau)

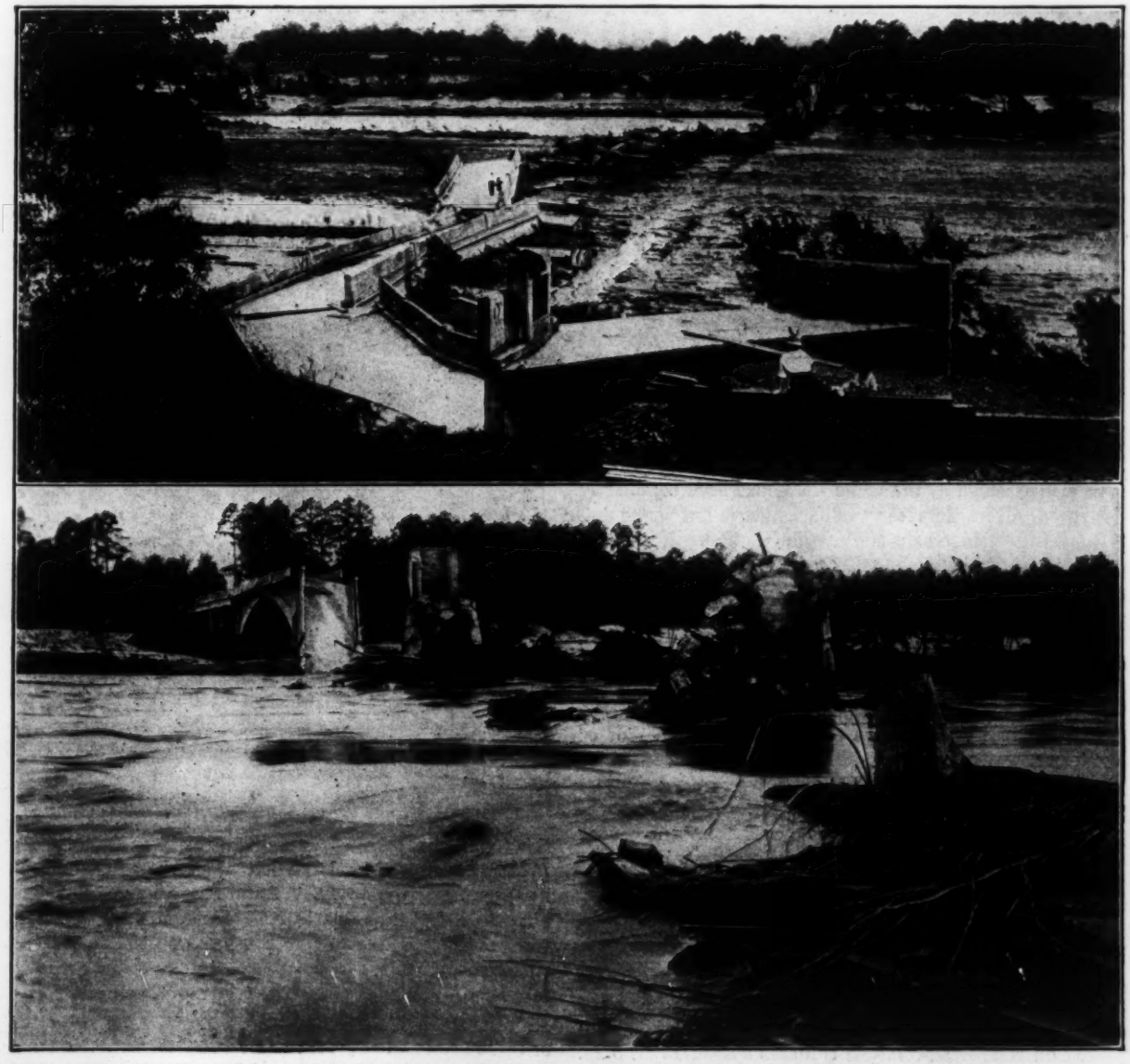
Stations	Day of Month 6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Mobile, Ala.	6.64	1.40	4.82	0.34	0	0.08	1.90	0.02	0.22	2.10	0.06	0	0	0	0.04	0.08	0	0.16	0.92	18.78
Pensacola, Fla.	2.46	0.24	1.38	2.91	0	0	0.48	0.10	0.20	0.08	0.74	0.40	0	0	0.68	0.92	1.16	0.34	1.14	13.23
Meridian, Miss.	0.03	4.58	0.64	0.26	0	0.02	0.92	0.08	0	0	0	0	0.98	0.76	0.94	1.28	0.28	0	0	10.77
Montgomery, Ala.	1.08	5.08	1.96	1.18	0.06	1.14	0.52	0.08	0.02	0	1.48	0	0	0.04	0.70	0.14	0.02	0.06	0.16	13.72
Birmingham, Ala.	0.54	6.70	5.00	0.38	0.78	1.10	0	0	0.06	0.80	0.18	2.60	0	0.12	0.12	0.38	0	0.60	0	19.36
Augusta, Ga.	0.02	1.06	0.10	0.36	0.46	0.24	0	0	0.20	0.28	0.30	0	0.42	0	0	0	0	0.64	0.72	4.80
Atlanta, Ga.	0.18	0.90	3.84	2.08	0.44	0.80	0.14	0	0	0.02	0.06	0.01	0.10	0.04	0.94	0.02	0.14	0.04	0.01	9.76
Macon, Ga.	0.34	1.60	1.82	0.36	0.54	1.02	0.32	0	0	0	0	0	0	3.34	0.32	0.02	0.18	0.80	0.66	11.32
Thomasville, Ga.	0.52	0.22	1.80	3.88	0.76	0.46	0.16	0	0.40	0	0.58	0.32	0.16	0	0	0.26	0	1.14	0.80	11.46
Savannah, Ga.	0.76	1.24	0	0.36	0.08	0	0	0	0.08	0.10	0	0	0	0	0	0.20	0	0.90	0.40	4.12
Columbia, S. C.	0	0	0	0.98	0.58	0.14	0.02	0	0.04	1.56	0.14	0	0	0	0	0	0.38	0.28	2.20	6.32
Charleston, S. C.	0.66	0	0	0	0	0	0	0.08	2.04	2.28	0	0	0	0	0	0	0.06	0.84	3.40	9.36
Charlotte, N. C.	0	0	0	1.28	1.48	0.16	0	0	0	3.62	1.50	0.01	0	0	0	1.02	0.44	0.96	3.06	13.53
Asheville, N. C.	0	0	0.10	2.36	1.12	0.20	0.06	0	0.04	0.58	1.72	0.52	0.36	0	0.48	0	0.08	0.36	0	7.98
Raleigh, N. C.	0	0	0	0	0.08	0	0.36	0	0	0.80	0.01	0.01	0.01	0	0	0.28	1.36	0.60	0.98	4.49
Knoxville, Tenn.	0	0	0	1.08	0.54	0.16	0	0	0.01	0.01	1.54	0.01	1.02	0.14	0	0.32	1.02	0.26	0	6.11
Chattanooga, Tenn.	0	0.30	3.20	3.56	2.56	1.08	0.06	0.38	0.54	0	0	0	0.08	0.14	0	0	0.10	0.04	0	12.04

FIGS. 2 AND 3. THREE WRECKED CATAWBA RIVER BRIDGES AT
Left-Hand View—Mt. Holly side; P. & N. bridge at left, county bridge approach with automobiles at right

FIGS. 4 AND 5. UPPER VIEW—PIEDMONT & NORTHERN RY. BRIDGE. LOWER VIEW—COUNTY BRIDGE, BOTH TAKEN ON BANK OPPOSITE MT. HOLLY
Lower view shows Seaboard arch abutment on far bank near right



MT. HOLLY, N. C.; PIEDMONT & NORTHERN, SEABOARD, AND COUNTY
Right-Hand View—Bank opposite Mt. Holly; county bridge at left, Seaboard in center, P. & N. at right



FIGS. 6 AND 7. TWO VIEWS OF WRECKED CONCRETE BRIDGE OVER CATAWBA RIVER AT SLOANS FERRY, N. C.
Lower view looking toward Gaston County bank

than the flood of 1901. At Fort Mill, S. C., the records show that the flood was 42 ft. above low water and 15 ft. higher than that of 1912. The Broad River at Camden, S. C., reached a crest of 45.3 ft. above low water. The Congaree at Columbia, S. C., was 31.5 ft. above and the Catawba at Mount Holly, N. C., was 47 ft. above low water.

No large cities were in the way of the floods so the damage was confined to the smaller settlements, to washouts of mills in the riparian districts, and to destruction of bridges and railway embankments. Failures of dams of any size have not been reported nor have any hydro-electric projects been more than temporarily deranged. It is impossible at the present time to make a close estimate of the aggregate flood damage. The more spectacular instances, as for example the Armon Cotton Mills at Mountain Island and the Southern Ry. bridge at Belmont, will run into big figures; other individual cases are quite large.

The following figures were compiled by the Charlotte *Observer;* they are conservative and as nearly accurate as possible at the present time.

Damage to power stations and other vested interests of Southern Power Co. along Catawba and Broad Rivers	$1,000,000
Dravo power plant and other power stations along Broad River and tributaries	500,000
Yadkin River hydro-electric damage at Clemons, Whitney and other places	250,000
Textile interests along Catawba, South Fork, Broad, Yadkin and French Broad Rivers	750,000
Railway bridges across Catawba River of Southern, Seaboard, Piedmont & Northern and C. & N. W. railways	500,000
Railway bridges across Broad, Upper Yadkin, French Broad and tributaries	500,000
State and County highway bridges	1,000,000
Track and property damage to railroads exclusive of bridges and approaches	2,000,000
Damages sustained by Southern Bell, Western Union and Postal Telegraph companies	200,000
Damage to growing crops, livestock, farm buildings and other agricultural operations	5,000,000
Total	$11,700,000

The accompanying views show bridge washouts at Mt. Holly, N. C., and at Sloans Ferry, N. C., both on the Catawba River. At Mt. Holly there were three bridges, two railway and one highway, and they are all gone. At Sloans Ferry there was a long reinforced-concrete arch bridge which as the views show, has been completely destroyed. Here the river was 56 ft. above low water and 4 ft. over the bridge balustrade. The Southern Ry. bridge over the Catawba at Belmont, N. C., a 1,400-ft. steel-truss structure, is completely out.

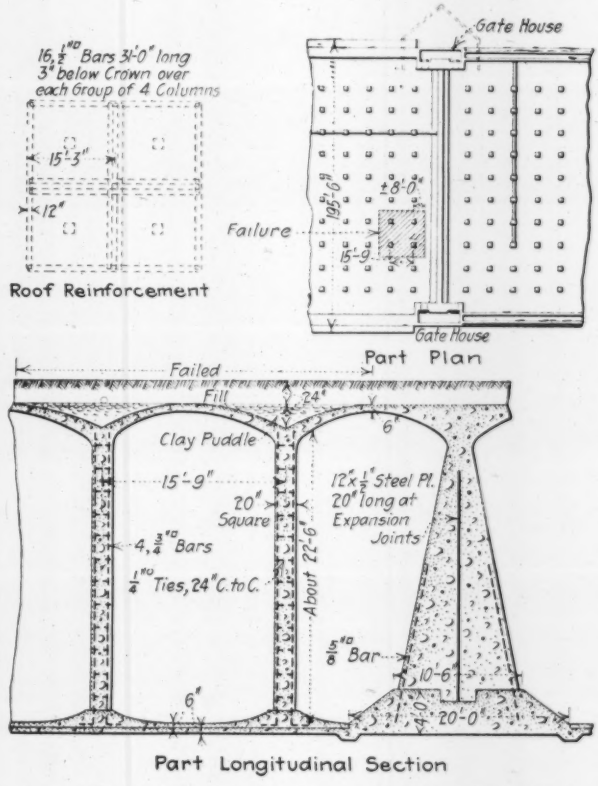
Cleveland Filter Roof Collapse Under Investigation

The collapse of four bays of the groined arch roof of the clear water basin at the new West Side filters, Cleveland, Ohio, on July 16, as briefly noted in last week's issue, is still under investigation and no official report is as yet available. The general nature of the design and of the collapse, however, are presented herewith.

The clear water basin of the filtration system is located northwest of the main plant which was completed about a year and a half ago. This basin, a covered reservoir 938 ft. long and 195 ft. 6 in. wide, is of the customary reinforced-concrete groined arch roof and base design, as shown in the accompanying details. The roof is supported on reinforced-concrete columns spaced 15 ft. 9 in. each way, about 22 ft. 6 in. high, 20 in. square and reinforced with four ¾-in. rods tied together every 24 in. with ¼-in. wire. These columns rest on a 6-in. floor with a groined arch distribution 6 in. thick at the crown. The roof units are also groined arches with elliptical intrados and parabolic extrados. This arch is 6 in. thick at crown and about 12 in. at spring. The roof will eventually carry a 24-in. clay fill over the columns plus a 24-in. earth fill over all, but no fill has as yet been placed.

Reinforcement of the roof consists in the rod grouping shown in detail in the drawing. This system, it will be seen, separates the roof into panels over four columns with expansion joints at the crowns of the border arches.

The collapsed section was one of these panel groups located (as shown hatched in the accompanying drawing)



DETAILS OF CLEAR WATER BASIN, CLEVELAND WEST SIDE FILTERS

at the cross wall which separates the reservoir into two basins. The collapse is complete over these four columns. No one was around the work at the time. The concreting had been completed some time and the centering was all out.

There is criticism both of the concrete and the foundations and investigators for both city and contractor (Walsh Construction Co.) are at work. It seems evident, however, that the primary failure was in the columns, but whether it was due to collapse from pure weakness, from movement due to side pressure or from foundation sinking is not now certain.

Bids on Ohio State Road Work, to the amount of $1,240,495, were opened on two days, July 20 and 21. About 108 mi. of roads are to be improved under these contracts. On four contracts opened July 20 no bids were received—an unusual occurrence in these days of roadbuilding. Most of the bids were below engineers' estimates.

News of the Engineering World

Disastrous Gas Explosion in Cleveland Tunnel

Inflammable gas in pockets and veins of the clay soil through which the new water intake tunnel of Cleveland, O., under Lake Erie is being driven exploded on Monday, July 24, 1916, and killed 10 men working in the tunnel. Two rescue parties were overcome, and 10 of their number died. The accident occurred in the lake heading, now 1,400 ft. long, which is being driven landward from the future intake crib, located 5 mi. from shore. Both this and the land heading are driven by shield under compressed air at 20 lb. per sq.in. The airlocks are near the entrance shafts, and in both headings practically the whole length of tunnel is under air pressure in a single unbroken length—lengths 1,400 and 13,000 ft. for the lake heading and land heading respectively.

The tunnel, 10 ft. in inside diameter and 120 ft. below lake surface, is to have a completed length of 16,000 ft., starting at Crib 3, an old crib in the lake, 8,000 ft. from shore off the foot of West 50th St. Most of the work has been handled from a short shaft through an old 7-ft. tunnel extending out to Crib 3, but there is also a hoist shaft at the latter crib. The new intake crib, sunk in 1914, was subsequently also used for starting a heading, a shaft being sunk through its center to tunnel level. This lake heading has advanced slowly, while the shore heading drove forward at consistent speed of 15 to 22 ft. per day.

The soil is clay, hard enough to support itself without serious deformation for some hours, though squeezing perceptibly in the course of a day or more. Throughout the work, small pockets of inflammable gas have been struck, as has been the case in nearly all prior Cleveland tunneling in the clay. Generally the gas in the tunnel air if present at all was in very small amounts and could not be detected by the senses. Most rigid rules against use of matches or open lights and against handling electric circuits in a way to produce sparks were in force.

The gas-carrying pockets were small, and often were mere porous spots or sand streaks. The gas in them was under pressure, and was usually noticed by the hiss of its blowing out. In other respects the soil was absolutely tight, and there was no escape of air or inflow of water, except the slight drip from the moisture of the soil. There was no ventilation system, but a 4-in. blowpipe was available for blowing off either water or air.

A distinguishing feature of the tunnel is the character of the lining. This is of concrete blocks, in rings 18 in. wide by 10 to 11 in. thick, six segment blocks to the ring, each block weighing 1,200 lb. The tongue-and-groove joints of the blocks are laid up in cement mortar, and are pointed up some hundred feet or more back of the face. In spite of the pointing, the lining as a whole probably remained permeable to gas.

The tunnel is being built by city day labor, under the management of the city's water department.

Investigating Road Conditions in New Jersey

New Jersey divides with Massachusetts the honor of being the first state in the Union to undertake improved road construction on a large scale. For fully twenty years, from 1890 to 1910, New Jersey's macadam roads were held up as a model of good practice and were visited by highway engineers from all over the country.

The enormous development of automobile traffic that has taken place during the past half-dozen years has revolutionized road traffic conditions everywhere, but nowhere more so than in New Jersey. New Jersey roads are used not only by the state's own dense population, but by residents of the great cities of New York and Philadelphia, which lie adjacent on either side. Under the stress of this heavy automobile traffic the wear and tear on New Jersey improved roads has far outrun the provision for maintenance, and it is necessary for the state to take radical measures for the improvement of its entire system of highways. The recent legislature provided for a state bond issue of $7,000,000 for roadwork, subject to approval by popular vote at the November election.

Further, and not less important, the legislature created a State Commission on Road Legislation to investigate the whole matter of improved highways and formulate a policy for the state. The members of this commission are John W. Herbert, chairman; Joseph H. Wood, Horace A. Bonnell and Edwin A. Stevens, State Highway Commissioner. The commission issued on July 14 a circular letter addressed to a number of prominent citizens of New Jersey, containing various suggestive questions regarding road conditions and road reforms. The questions, which are of interest in other states besides New Jersey, are given herewith:

The main trunk highways of New Jersey are breaking down under the terrific strain to which they are subjected by modern traffic. Many of the feeder roads to these trunk highways are in bad shape. The roads running through the outlying districts of the state and connecting with these "feeders" have never been in satisfactory condition. The construction of much-needed new roads is coming to a standstill, the maintenance of old roads even at enormous expense is not keeping pace with the daily wear and tear of travel. Transportation, which is the life blood of civilization and prosperity, is thereby hampered, and the development and improvement of New Jersey are being retarded.

What is the trouble? Does the fault lie with a tangled mass of unintelligible road laws? Are we struggling hopelessly to administer the road laws in township, county and state by numerous undefined and varied types of road organizations? Are many of the employees of these road organizations indifferent, untrained or inefficient? Do these employees, elected by the people or appointed for political reasons, hold office for such short periods of time and under such conditions that they cannot become effective in their work?

Are we building and maintaining our roads by unsound or unbusinesslike measures of finance? How much interest are we paying on bonds issued to build poor roads which have gone to pieces or will go to pieces before the bonds mature? How much money have we saved in our funds to pay off these bonds at maturity? Does our money go into roads or into unnecessary and wasteful charges?

Do we foolishly try to save money by building cheap roads that will last months when we ought to practice true economy by laying down roads that will last years?

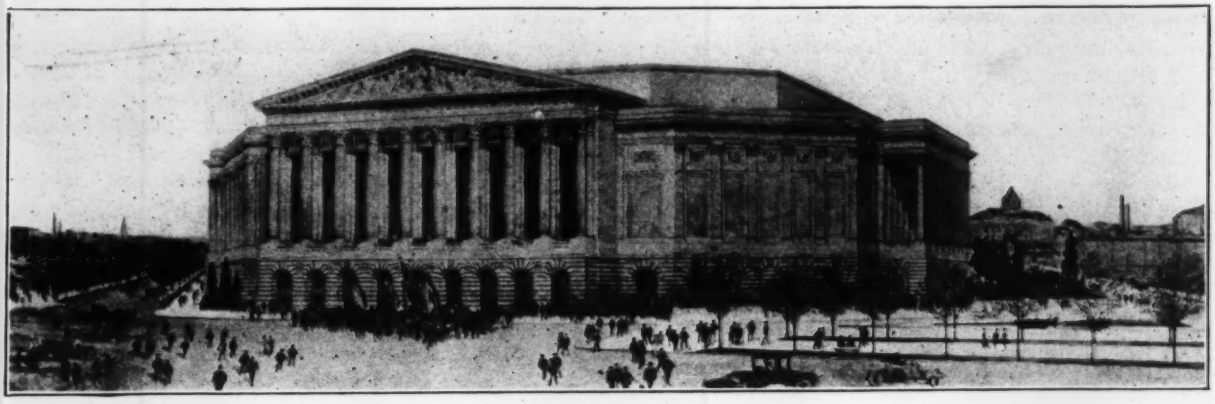
Are we getting full and honest returns on every road contract into which we enter? Are we selecting the right materials and the proper sort of road construction and maintenance for the several diversified localities of the state? Should we limit the traffic on highways as to the weight of vehicles and load, and if so, what should be the limit, and should we make regulations as to the width of tires?

In a word, do we have a scientific, efficient and far-sighted road policy, capable of automatic expansion and application to meet increased growth and change of traffic conditions, or do we act only under the stress of necessity, striving to get good roads by passing an annual installment of road legislation?

Please bear in mind that the commission is interested in every phase of the road situation and is not committed to any preconceived ideas of road construction, road maintenance, road administration or road finance. It is believed, however, that there are certain fundamental principles of law, finance, administration and operation underlying this whole subject of good roads.

New Municipal Auditorium in Philadelphia

A new municipal auditorium or convention hall of extraordinary size is about to be started by the City of Philadelphia. A fund of $1,500,000 was provided for by city vote some years ago, but construction has been held up by some technicalities which have recently been overcome so that the project can now be carried to a successful conclusion. The auditorium, an architect's perspective of which is shown herewith, is to be located on the new Parkway, the wide boulevard extending from the City Hall northwesterly to the entrance of Fairmount Park. The building will be between 21st, 22nd, Hamilton and Callowhill St., in the immediate vicinity of the proposed library and art museum.



THE PROPOSED NEW MUNICIPAL AUDITORIUM ON THE PARKWAY IN PHILADELPHIA

The building fronts on the Parkway 248 ft. and is 362 ft. deep. It will have an auditorium 225 ft. square provided with two galleries, so that the total seating capacity will be about 15,000 people. When used for exhibition purposes only, there will be a capacity of 91,000 sq.ft. In addition there is a stage 50 ft. deep with a proscenium opening of 100 ft. with a seating capacity of 1,000 people. A special arrangement for exits, both in number and provision for inclines, makes it possible to empty the entire auditorium in about five minutes. The project is under the direction of the Mayor, and of the Director of the Department of Public Works, George E. Datesman. The architect is John T. Windrim.

St. Louis County Road Bonds Declared Valid

The $3,000,000 issue of bonds for improving the roads of St. Louis County, Missouri, has been declared valid by the supreme court of the state. The entire amount need not be issued at once, but may be issued in installments. One-half the issue must be in denominations of $100 and the bonds are redeemable at any time within 20 years. The ruling of the court applies to the proposed issue of $500,000 in exactly the same manner, and the decision means that county road work in Missouri will soon begin in earnest.

One result of the court's interpretation of the bond-issue statute is to cause James C. Travilla, former Street Commissioner of St. Louis, to lose his position as Assistant to the County Highway Engineer, to which he was appointed last April at a salary of $4,800 per annum. The section of the statute under which he was appointed is declared invalid. It is reported, however, that a way will be found to retain his services.

City Replanning in St. Louis

The City of St. Louis is in the shape of a fan, the business district being in the center and the portion which would be the sticks of a fan representing the blighted or depreciated district.

On account of inadequate traffic arteries toward the north and south, most of the traffic passes directly west across this depreciated district. This travel has been concentrated on Locust St. and has resulted in the complete rebuilding of this street, largely by the automobile industries. The property values along Locust St. have again reached a high point. The congestion of traffic on this street has been so great that in connection with the resurfacing of the street, which is required this year, the curbing will be set back 3 ft. on each side.

Parallel and next adjoining Locust St. is Olive St., which carries a very heavy street-car traffic and is paved with granite. Although only a block from Locust St., the property along Olive St. has failed to appreciate in value. This has been a matter of serious concern to the property holders, and at a recent meeting of the owners in the office of the Director of Streets and Sewers a large majority expressed themselves as favoring a repaving of wood block and the widening of the roadway in the same manner as will be applied to Locust St. In this way it is

hoped to attract some of the present congested traffic on Locust St. to Olive St. and thereby secure a revival of business along the latter street.

The City Plan Committee of the Business Men's League is urging an appropriation of $15,000 for a districting study in St. Louis. The St. Louis City Plan Commission some time ago requested the various civic organizations to appoint committees on city planning. This has been done by a great number of organizations, among them the Business Men's League, Civic League, Institute of Architects and the Engineers' Club. These committees have been meeting at intervals with the City Plan Commission, and certain phases of work have been assigned to the organization committees for study. The recommendation by the committee from the Business Men's League is a result of its study of the districting question.

River Pollution Case Settled

Pollution of the Fox River, in Illinois, by Elgin, Aurora and other municipalities, has been a source of complaint for some years, and in June, 1914, the Illinois Rivers and Lakes Commission issued an order to the cities to cease this pollution. Appeals against the enforcement of the order have been pending since then, but were dismissed by the Sangamon County Circuit Court on June 26, 1916. The dismissal is by voluntary agreement with the cities of Elgin and Aurora, and means that primary sedimentation tanks or sewage-treating apparatus must be installed by Jan. 31, 1917.

Pennsylvania Water Companies Cannot Require Meters

A ruling last week of the Pennsylvania Public Service Commission is of interest to water-works men. A consumer complained because he had been required to install a meter when some other consumers were not required to do so. Investigation showed only about one-third of the consumers' services were metered, and it was decided that the company "having no pronounced policy in favor of the complete metering of its system" must make the complainant a flat rate. Another decision refuses to find injustice in the action of a water company in shutting off the water-supply for nonpayment of water rents, after reasonable notice.

City Board of Survey in Massachusetts

A slight advance in the control of city planning in Massachusetts is made possible by an act of the Massachusetts legislature, approved May 10, 1916 (Chap. 190).

Several years ago the legislature passed an act providing that all cities and every town of 10,000 population and upward must create planning boards. These boards had few but advisory powers and powers of investigation.

The act of 1916 provides that the mayor of any city, with the approval of the city council or board of aldermen, may appoint a board of survey of three members in January of any year and fix their compensation. The city engineer is to act as clerk of such a board.

Beyond the permissive power to create boards of survey, the act contains one mandatory and one permissive feature. The mandatory provision is that where a board of survey has been created no person, firm or corporation shall open a street without submitting to the board of survey "suitable plans and profiles" showing "also the method of drainage of the adjacent or contiguous territory." Provision is made for public advertisements and hearings and for the approval or modification of the plans by the board and their filing in the office of the city engineer. After all this has been done, "no street or way in the territory to which the plans relate shall be laid out or constructed except in accordance therewith or with such further plans as may subsequently be approved by the board."

The permissive power of boards of survey under the Massachusetts act gives the board a considerable degree of city-planning latitude, when directed to exercise it by the local planning board and the city council. The first part of the section conferring this power is as follows:

> Section 3. The board of survey may, and upon the vote of the local planning board and the city council or board of aldermen shall, from time to time cause to be made by the city engineer, under its direction, plans of such territory or sections of land in the city as the board of survey or the said planning board may deem necessary, showing thereon the location of such streets or ways, whether already laid out or not, as, in the opinion of the board, the interest of the public may or will require in such territory, showing clearly the direction, width and grades of each street or way, and a plan of drainage, and said board may incur such expenses as it may deem necessary therefor, not exceeding the amount of money appropriated for the purpose.

Provision is made for public advertisement, hearing and approval, as already outlined, for private street openings.

Harahan Bridge Opened to Railway Traffic

The new Mississippi River bridge at Memphis, the Harahan Bridge, was opened for traffic on July 15, 1916, and a day or two afterward the trains of the three roads which joined in building the bridge, the Cotton Belt, the Iron Mountain, and the Rock Island were diverted to the new bridge. The bridge is double-track, but only one track can be used over the south approach which is as yet not completed. The vehicle roadway of the bridge is also not completed, but this is expected to be ready for traffic in the fall of this year. Crittenden County, Ark., will build a two-mile viaduct to connect with the highway bridge. The bridge was built by the Pennsylvania Steel Co. on substructure built by the Union Bridge and Construction Co. The total cost was about $5,000,000, exclusive of approaches. Ralph Modjeski was consulting engineer for the superstructure. M. B. Case was resident engineer.

Clarifying San Diego Water

An increase in the period of coagulation before mechanical filtration was necessary to free the water supply of San Diego, Calif., from a load of very finely divided clayey matter resulting from the floods of last winter and decreased storage and settling capacity due to the destruction of the Lower Otay dam. The story is concisely told in the May report of F. M. Lockwood, Manager Operating Department of San Diego, as follows:

> Much attention has been given to the question of clarifying San Diego's water-supply. During the floods, the runoff into the Upper Otay reservoir, which supplies the greater portion of the water now being used in San Diego, contained an unusual amount of clayey silt, which, contrary to all precedent, still remains suspended, practically no settlement having oc-

curred, even to this date. A coagulating plant near the filter at Lower Otay remedied this to a great extent, but a slight discoloration still existed, even after passing through the filters. This, however, has now been corrected by installing a coagulating plant about half-way between the Upper and Lower Otays, some two miles above the filter. This plant consists of two 2,000-gal. redwood tanks, with their accompanying regulating tanks; a 3-hp. gas engine and a 2-in. centrifugal pump, and, being placed at this point, gives the coagulant from 1 to 1½ hr. to act on the water before it enters the filter instead of from 1½ to 2 min., as was the case with the old coagulating plant. The water now flowing from the filters is absolutely clear, and, being treated with chlorine at the University Heights reservoir, into which all water empties before being turned into the mains, is, according to bacteriological tests, of a safe, healthful quality.

New Bridge Company Formed

In connection with the merger of the Pennsylvania Steel Co. and the Maryland Steel Co. under the general direction of the Bethlehem Steel Co., it is announced that the bridge and structural work of the combination will hereafter be handled by a new company, to be known as the Bethlehem Steel Bridge Co. of Delaware. G. H. Blakely, who has been in charge of the structural department of the Bethlehem Steel Co. becomes president of the new company and Thomas Earl, formerly superintendent of the bridge and construction department of the Pennsylvania Steel Co., will be made vice-president.

This company will operate hereafter on bridge work and there will be no competition in steel structural work between the bridge company and the various fabricating interests to which the Bethlehem company has long supplied material. The new company will handle all estimating work, secure contracts and direct erection work. The headquarters will be at South Bethlehem, Penn.

The Public Buildings Appropriation Bill has been abandoned for the present session of Congress and with it goes the proposed Bureau of Public Buildings, which was to supersede the office of Supervising Architect of the Treasury.

Investigations for the Government Nitrate Plant provided for by the Army Appropriation Bill are being made by Colonel Newcomer and Major Kelly, of the Corps of Engineers, so far as all questions regarding the proposed site of the plant and its construction are concerned. A committee representing the Nashville Section of the Engineering Association of the South is to urge the selection of the Muscle Shoals site on the Tennessee River. John Howe Peyton, President of the Nashville, Chattanooga & St. Louis R.R., is chairman of the Committee and Prof. W. G. Waldo, of Vanderbilt University, is the Secretary. Investigations with respect to the process to be used in the manufacture of nitrate are being made by Colonel Hoffer of the Bureau of Ordnance.

A Brick Chimney Settled 8 Ft. killing two men and injuring three others at Corning, N. Y., on July 14, at the Corning glass works. The men, employed by the H. L. Dixon Co., of Pittsburgh, were engaged in repairing a furnace when the collapse occurred. The chimney was supported on brick arches, which were built over the openings in the base of the furnace, which give access to the glass pots. It is supposed, locally, that the foundation or arches had been weakened during repairs and had not been properly shored. As the chimney sank it also tilted, so that its top was 4 ft. out of plumb. Two cracks appeared in the side. The chimney is too badly damaged to be repaired, but its removal was difficult owing to the danger of damaging two new tank furnaces nearby, valued at $100,000 each.

Whether Water-Power Legislation by the present Congress will be effective in reviving activity in water-power development is still in doubt. The bill relative to water-power sites on the public lands appears to have been abandoned for the session. The Adamson bill, relating to the construction of dams across navigable rivers, which passed the Senate some months ago, has been radically amended by the House to permit the Secretary of War to assess an annual charge as a rental for the use of water-power privileges, this rental to be subject to adjustment at the end of twenty years and every ten years thereafter by the then Secretary of War. The House also inserted a clause providing that if the government take over the property at the expiration of the lease, it need take only the generating plant and the transmission line and is not obliged to take any distribution system therewith connected. Both bills have been referred to a Conference Committee, and the House Conferees are Messrs. Adamson, Simms, and Esch.

The Military Engineering Committee of New York City has prepared a circular directing the attention of 4,000 engineers, who enrolled last winter for the military engineering lectures, to the 22nd Engineers of New York, as a means of gaining some military knowledge. This circular is being sent out this week. The two battalions of the New York Engineers have been mustered into Federal service and a depot battalion is being organized, under Sec. 120 of the Military Law of New York, which states in part that such depot units shall not be called on for duty outside the state, except in case of emergency to be determined by the Governor, but the members thereof may be transferred by him to fill temporary or permanent vacancies or make up a deficiency of strength in the organization for which the depot unit is formed. The enlisted personnel of depot units is divided into classes designated respectively as Class A and Class B. The former consists of men available to fill vacancies in the organization of the National Guard in the service of the United States. Class B consists of all other enlisted men of such organizations, and they will take an oath to serve the state only. Engineers enlisting in the depot battalion will be given a course of instruction covered by a drill one night per week from 8:15 to 10:30, and lectures, quizzes, and practical work on the drill floor in the various branches of military and engineering work. Enlistment in Class A for active service is in the National Guard of the United States and of the State of New York for a period of three years in service and three years in reserve; while the enlistment in Class B is in the National Guard of New York only, for a period of three years unless sooner discharged by proper authority. Class B men will be discharged upon the return of the active battalions. Enlistment in Class B will not interfere with attendance at the training camp at Plattsburg. It will not preclude one from joining the Volunteers or transferring to another military organization, nor will it prejudice one's standing in the Reserve Corps of Engineer Officers. To enlist in either class report at 8:20 p.m. to Major John F. Fairchild, at the Armory, 168th St. near Broadway.

PERSONALS

Frank Minkler has resigned as Street Commissioner of Carthage, Mo., to accept a position with Carthage special road district.

F. A. Torkelson has been appointed City Engineer of Green Bay, Wis., to succeed August Brauns. He is a graduate of the University of Wisconsin.

I. H. Piotrowsky, formerly with the Akron (Ohio) city water-works, has been appointed Superintendent of the Barberton (Ohio) city water-works.

F. E. Howells, M. Am. Soc. M. E., Superintendent of Shops of the Steelton plant of the Bethlehem Steel Co., has been promoted to be Assistant Mechanical Engineer.

Leander Dorsey, Assoc. M. Am. Soc. C. E., has resigned as Superintendent of the Whiting-Turner Construction Co., Baltimore, Md., to become Manager of the contracting department of the Cram Engineering Co., also of Baltimore.

E. E. Entwisle, Superintendent of the Maintenance Department of the Steelton plant of the Bethlehem Steel Co., has been made Mechanical Engineer in charge of construction work, as Assistant to the Chief Engineer, C. P. Turner.

G. F. Nicholson, District Engineer of Terminals on the East Waterway, Seattle, Wash., has been appointed Acting Chief Engineer of the Port of Seattle, to succeed J. R. West, whose resignation was noted in these columns July 13.

George Kuhrts, Chief Engineer of the Los Angeles Railway Corporation, Los Angeles, Calif., has been appointed Assistant General Manager of the company. He is succeeded as Chief Engineer by Thomas Bulpin, former Assistant Chief Engineer.

D. W. Thrower, District Engineer of the Yazoo & Mississippi Valley R.R., at Memphis, Tenn., has been appointed Assistant Valuation Engineer of the Illinois Central R.R. and the Yazoo & Mississippi Valley R.R., with headquarters at Chicago, Ill.

Milton B. Morgan, former Assistant Engineer of Maintenance-of-Way of the Illinois Central R.R. and the Yazoo & Mississippi Valley R.R., is now District Engineer of Yazoo & Mississippi Valley R.R., with headquarters at Memphis, Tenn., succeeding D. W. Thrower, transferred as noted elsewhere.

D. G. Cunningham has been appointed Superintendent of Motive Power of the Denver & Salt Lake R.R., with office at Denver, Colo. He is a graduate of the Virginia Polytechnic Institute, class of 1898, and has been with the motive-power departments of the Norfolk & Western R.R. and the Atchison, Topeka & Santa Fe Ry.

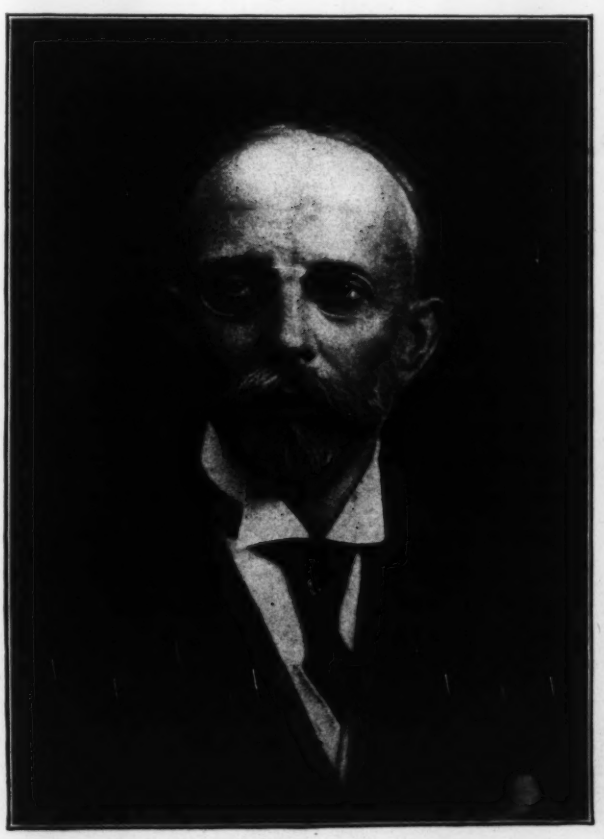
C. O. Doughaday has resigned as Division Superintendent of the Pittsburgh, Penn., Bureau of Water to accept a position with the British-American Chemical Co., New York City. The mechanical division of the Bureau of Water, of which Mr. Doughaday had charge, is now in temporary charge of F. W. Lyon, Assoc. M. Am. Soc. C. E.

A. W. Johnston, M. Am. Soc. C. E., General Manager of the New York, Chicago & St. Louis R.R., has been appointed Assistant to the President. The office of General Manager will not be filled immediately, and the duties of the office will continue to be performed by Mr. Johnston. He is a graduate of the Massachusetts Institute of Technology and entered the railroad service in 1875.

A. C. Garrison, only son of the late D. E. Garrison, whose death was noted in the obituary columns of last week, has been elected President of the Corrugated Bar Co., Buffalo, N. Y., to succeed his father. **A. L. Johnson,** M. Am. Soc. C. E., has been elected Vice-President and General Manager and **W. H. Kennedy** has been elected Vice-President and Treasurer. **W. M. Armstrong,** formerly Vice-President and Sales Manager, has resigned.

OBITUARY

Charles William Henry Kirchhoff, twice President of the American Institute of Mining Engineers, for many years Editor-in-Chief of the "Iron Age," died July 23 at his summer home at Asbury Park, N. J. He was born in San Francisco, Calif., Mar. 28, 1853. He was graduated from the Royal School of Mines, Clausthal, Germany, in 1874. He returned to this country as Chemist of the Delaware Lead Refinery, Philadelphia. His editorial work began in 1877 as Assistant Editor of the "Metallurgical Review." The following year he joined the staff of the "Iron Age." From 1881 to 1884 he was Managing Editor of the "Engineering and Mining Journal," after which he returned to the "Iron Age" and in 1889 became its Editor-in-Chief, retiring in 1910. He was also Vice-President and General Manager of the David Williams Co., publishers of the "Iron Age." Mr. Kirchhoff was President of the American Institute of Mining Engineers in 1898-99 and again in 1911-12. He was a member of the American Society of Mechanical Engineers, the American Iron and Steel Institute, the Iron and Steel Institute of Great Britain and of other learned societies.



CHARLES W. H. KIRCHHOFF

ENGINEERING SOCIETIES

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Aug. 29-Sept. 1. Convention in Providence, R. I. Secy., James McFall, Roanoke, Va.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 4-7. Convention in Hot Springs, Va. Asst. Secy., E. A. Baily, 360 Pearl St., Brooklyn, N. Y.

THE TRAVELING ENGINEERS' ASSOCIATION.
Sept. 5-8. Annual meeting in Chicago, Ill. Secy., W. O. Thompson, care General Offices, N. Y. C. R.R., Cleveland, Ohio.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Week of Sept. 11. Annual meeting in Cleveland, Ohio. Secy., A. O. Backert, 12th and Chestnut St., Cleveland, Ohio.

THE AMERICAN INSTITUTE OF METALS.
Week of Sept. 11. Meeting in Cleveland, Ohio. Secy., W. M. Corse, 106 Morris Ave., Buffalo, N. Y.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS.
Sept. 11-16. Convention, Minneapolis, Minn. Secy., Fred W. Raven, 417 S. Dearborn St., Chicago.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 12. Convention in Atlantic City. Secy., A. P. Dane, Reading, Mass.

RAILWAY SIGNAL ASSOCIATION.
Sept. 12-14. Convention in Mackinac Island. Secy., C. C. Rosenburg, Myers Building, Bethlehem, Penn.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 13-15. Convention in Portland, Me. Secy., Willard Kent, Narragansett Pier, R. I.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 18-20. Convention in Philadelphia, Penn. Asst. Secy., C. D. Fawcett, 29 West 39th St., New York, N. Y.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS.
Sept. 18-22. Convention in Chicago. Secy., W. O. Oschmann, Oliver Iron and Steel Co., Pittsburgh, Penn.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 19-22. Convention in New York City. Secy., P. J. McAndrews.

MICHIGAN GAS ASSOCIATION.
Sept. 21-22. Annual meeting in Detroit, Mich. Secy., Clark R. Graves, Lansing, Mich.

AMERICAN PEAT SOCIETY.
Sept. 21-23. Annual meeting in Washington, D. C. Secy., Julius Bordollo, Kingsbridge, N. Y.

RAILWAY FIRE PROTECTION ASSOCIATION.
Oct. 3-5. Convention in New York City. Secy., C. B. Edwards, Mobile & Ohio R.R., Mobile, Ala.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 9-13. Convention in Newark, N. J. Secy., Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N. W. Ry., Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 24-27. Convention in Cincinnati, Ohio. Secy., Prof. Selskar M. Gunn, Boston, Mass.

The American Association of Engineers, through its national board of directors, has "resolved that all applications for membership received prior to Sept. 1, 1916, be accepted (provided the applicant has the required qualifications) at the present rate of no initiation fee and $10 per annum membership dues." According to an amendment to the constitution adopted at the May convention, an initiation fee of $2 will be charged after 1,000 applications have been received. It is estimated that this figure will be reached before Sept. 1. The initiation fee will be increased $2 for each 500 members secured above 1,000. The association has grown from 30 members to 891 in fourteen months, and it is now proposed that future members shall be required to possess higher qualifications.

Appliances and Materials

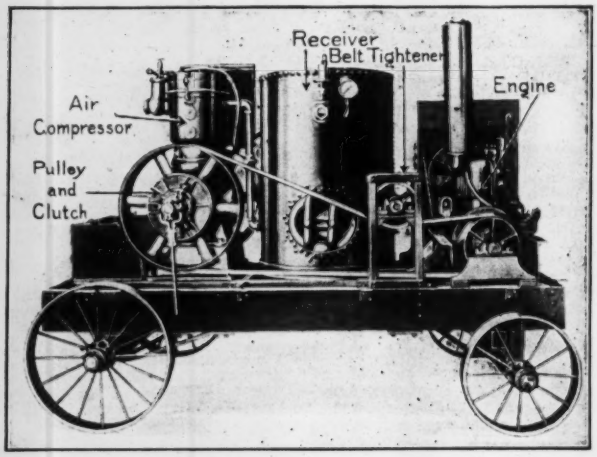
Portable Electric Inspection Lamp

A portable electric lamp outfit especially for inspection work in manholes, sewers, tunnels, car- and barge-loading stations, distilleries, etc., has been developed by the Hirsch Electric Mine Lamp Co., 314 N. 12th St., Philadelphia. It consists of a dry storage battery in case, a red warning-signal lamp on the case for use outside manholes, and a socket into which an incandescent lamp and reflector unit or a flexible-cable plug can be screwed.

* * *

Portable Air-Compressing Outfit

A portable air-compressor plant for use in construction work, bridge and structural-steel erection, and similar service, is shown in the accompanying illustration. It consists of a gasoline or kerosene engine (or electric motor), belted air-compressor, receiver and cooling apparatus, all mounted upon a steel frame carried by four wheels. When a gasoline engine is used it is of the four-cylinder automobile type but built specially for this work, with ample lubricating and cylinder cooling equipment. It can be disconnected from the compressor and used to operate other machinery. The compressor is of the Gardner-Rix high-speed vertical type, and is equipped with a water-cooling device independent of that for the engine. The outfit is built in various sizes, with capacity ranging from 21 to 450 cu.ft. of air per minute. The smallest size has a 7½-hp. engine, a single-acting compressor with 4½x4½-in. cylinder, and an 18x48-in. receiver. The largest size has a 120-hp. engine, double-acting compressor with 14x12-in. cylinder and two receivers 2½x6 ft. The former has a platform 2½x6 ft.



PORTABLE AIR-COMPRESSOR OUTFIT

and weighs about one ton. The latter has a platform 5½x13½ ft., and weighs 6½ tons. The plant is shown uncovered, but may be fitted with a canopy roof or enclosed entirely by a steel housing with removable panels in the sides and ends. The smaller sizes may be mounted on skids instead of wheels. The Chicago Department of Public Works has used one of these outfits, of 80 cu.ft. capacity, for calking water mains, and another of 140 cu.ft. capacity on bridge repair work. These plants are built by the Zin-Ho Mfg. Co., of Chicago.

* * *

Electric Dump-Car

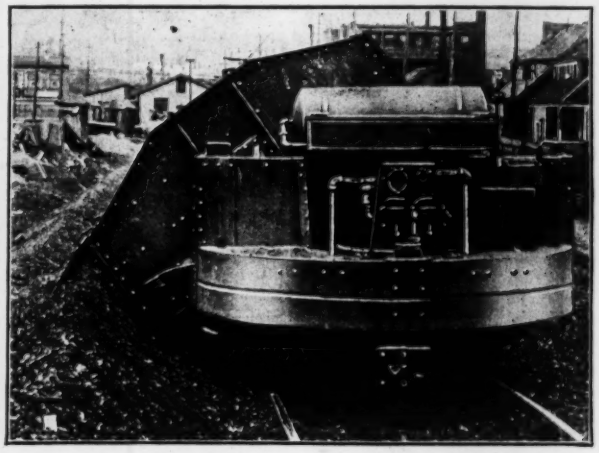
A new design of tilting dump-car having a low body but discharging its contents clear of the track is built by the Differential Car Co., of Nashville, Tenn. This combination of low center of gravity and clear dumping is effected by giving the body a lateral or traversing movement on the underframe. The inventor and designer is H. Fort Flowers, of New York.

The car is intended specially for street and electric-railway work, and its mechanism is electrically operated. It is so designed that when dumped from track below street paving (in the trench opened for track reconstruction) the pile of material will stand clear of the trench. With the track in normal position at the street level, the edge of the pile of material is about 12 in. from the rail.

When delivering material for ballasting or concrete the car usually moves forward while being dumped, in order to distribute the material in required proportion. The view shows one of its trailers in dumped position, making a fill on the Cleveland Electric Ry. The cars are 35½ ft. long, the capacity 18 cu.yd. The motor car weighs 23 tons, the trailer 15 tons.

The tilting body is divided into three compartments, each with its own side doors. Thus the contents of the compartments may be discharged at different points, or the entire load discharged at once. The car is mounted on trucks with 26-in. wheels.

The low position of the body is convenient for loading by hand or by steam shovel. The total height is 5 ft. 4½ in., but



DUMP-CAR WITH TRAVERSING BODY

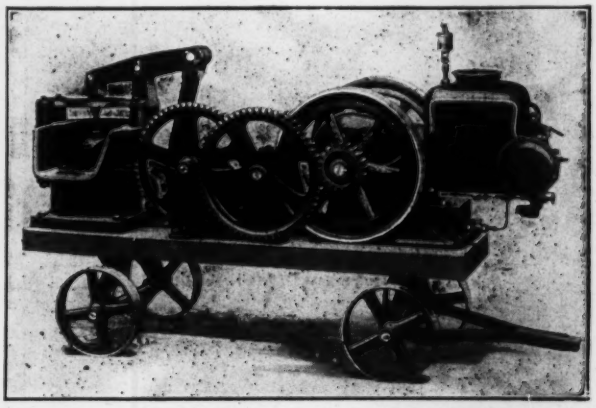
75% of the loading may be done with the side doors raised, and the material shoveled directly onto the floor, which is only 3 ft. 6 in. above the rail. With the doors closed, the body may be partly tilted to make the loading more convenient. In full tilted position, at an angle of 45°, the top of the side is only 2 ft. 6 in. above the rail.

The shifting and dumping of the body can be done in 17 sec. The traversing mechanism includes a motor-driven worm shaft, a worm wheel and chain drum and chains going over sheaves on each side of the body and joining at a center anchor pin.

* * *

Power-Operated Diaphragm Pump

The contractors' portable pumping outfit shown in the accompanying view has a diaphragm pump and gasoline engine mounted on a truck and weighs complete about 725 lb. The pump has a 3-in. diaphragm and guides on the piston rod insure vertical motion, thus eliminating side strains on the diaphragm. The horizontal engine, with cylinder 3¾x5 in., is rated at 1½ hp. It runs normally at 500 r.p.m. and is double-geared to the shaft from which the pump rod is operated, the gearing being such as to give 60 strokes per minute on



PORTABLE DIAPHRAGM-PUMP OUTFIT

the pump. The engine speed can be reduced by means of a speed-changing device. An oscillating magneto is used, no batteries being required. The outfit is said to be capable of handling 3,000 to 4,500 gal. per hr. (depending on conditions of working) at a cost of 3c. per hr. Its overall size is 63x24 in., with a height of 38½ in. The builders are D. A. Hinman & Co., of Sandwich, Ill.